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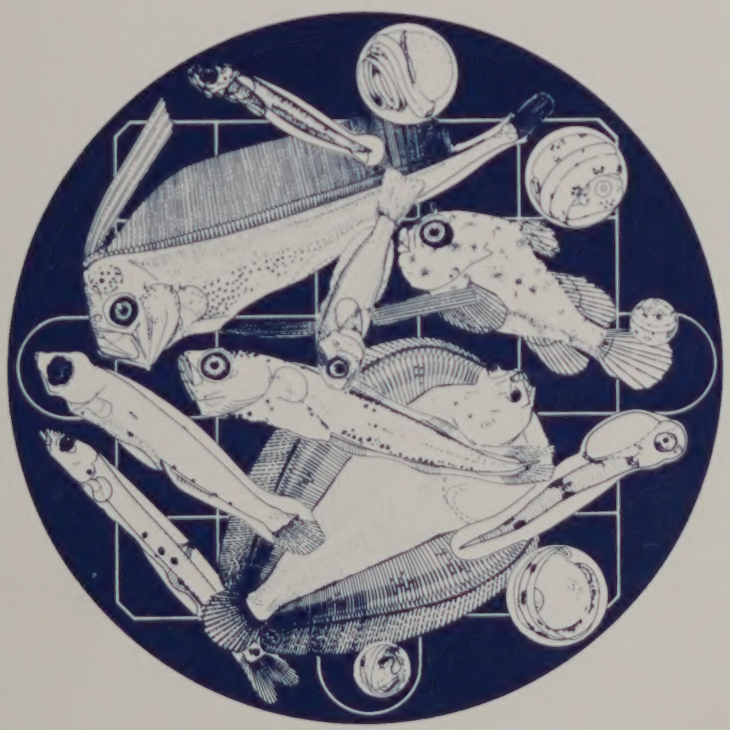
# Laboratory Guide to Early Life History Stages of Northeast Pacific Fishes

Ann C. Matarese, Arthur W. Kendall, Jr.,
Deborah M. Blood, and Beverly M. Vinter



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Ann C. Matarese
Arthur W. Kendall, Jr.
Deborah M. Blood
Beverly M. Vinter

October 1989

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# Laboratory Guide to Early Life History Stages of Northeast Pacific Fishes

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## ABSTRACT

**This laboratory guide presents taxonomic information on eggs and larvae of fishes of the Northeast Pacific Ocean (north of California) and the eastern Bering Sea. Included are early-life-history series, illustrations, and comparative descriptions of 232 species expected to spawn here, out of a total 627 species known to occur in marine waters of this area. Meristic and general life-history data are included, as well as diagnostic characters to help identify eggs and larvae. Most of this information has been gleaned from literature, with the addition of 200 previously unpublished illustrations.**

## Introduction

### Background

The importance of early-life-history studies to fisheries investigations and phylogenetic research has increased dramatically during the last decade. Early-life-history stages are now routinely used in fisheries studies to investigate the interannual variation in recruitment (e.g., Wooster 1983), and in studies of the phylogeny of fishes (e.g., Moser et al. 1984b). The fact that early-life-history stages of many species remain unknown in the northeastern Pacific Ocean limits their use in these disciplines, as well as in research on ecology, behavior, and the biological effects of pollution on fishes.

At the Northwest and Alaska Fisheries Center (NWAFC), progress in the identification and understanding of early-life-history stages of marine fishes has steadily increased. Our investigations beginning in 1965 were primarily aimed at determining spawning grounds and distribution of eggs and larvae for only one target species: the Pacific hake, *Merluccius productus*. Studies in the late sixties and early seventies concentrated on ascertaining abundance and horizontal distribution of the eggs and larvae of major taxa occurring off the northeast Pacific coast and in the Gulf of Alaska and Bering Sea. In addition to baseline studies on distribution and abundance, work has increasingly emphasized the use of egg and/or larval surveys (targeted on species such as walleye pollock, *Theragra chalcogramma*) to generate estimates of spawning stock biomass and to test hypotheses concerning the multitude of possible factors involved in the stock/recruitment relationship (e.g., feeding, predation, growth, and transport). These studies require the accurate identification of all early-life-history stages, from the egg stage to newly settled juveniles and adults. The ability to make such identifications is a direct result of taxonomic studies in our laboratory, especially for the family Gadidae. These studies have enabled identification of all gadid species occurring in the Northeast Pacific Ocean and have allowed additional research on development, osteology, and systematics (e.g., Matarese et al. 1981, Dunn and Vinter 1984, and Dunn and Matarese 1984).

The primary purpose of this laboratory guide is to allow expansion of the use of early-life-history studies in fisheries research by providing descriptive information necessary to insure accurate identification of eggs, larvae, and early juveniles of marine fishes in the northeastern Pacific Ocean and Bering Sea. The guide is designed to aid in species identification; thus, it includes little of the developmental information usually found in ontogenetic descriptions. We have placed emphasis on the accuracy and quality of illustrations, whether from the literature or originals drawn for this guide. In some cases, however, when specimens were not available, we reproduced substandard figures from the literature. Diagnostic characters are included, which enable identification of early-life-history stages of closely related and/or similar-looking taxa, as are comparative tables and figures which outline similarities and differences among taxa. Detailed information is included for species where considerable early-life-history data are available. For poorly known taxa, available information is given, sometimes limited to characters of adults of the species in the study area and a description of early-life-history stages of related species from other areas.

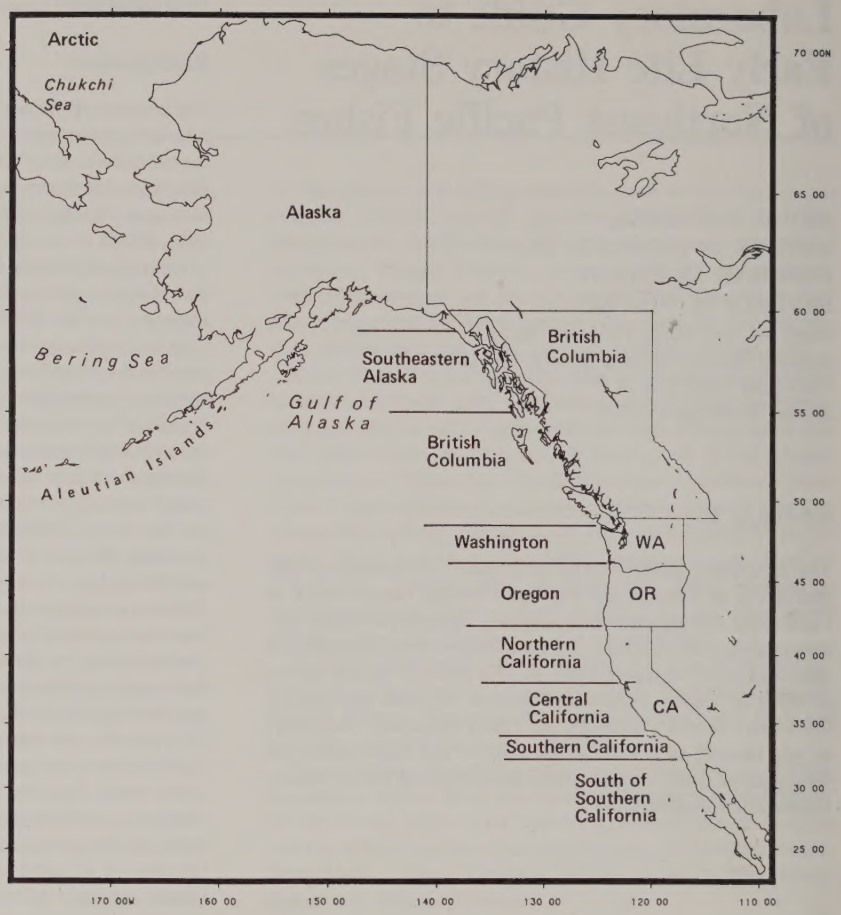


**Figure 1**
**Study area showing geographic ranges used in species accounts.**

## Geographic coverage

The geographic area covered is the Pacific Ocean between approximately 38°N and 66°N and west to 180°; however, we have included only those taxa with northern limits of distribution between Oregon and the northern Bering Sea (Fig. 1). Taxa restricted to California waters or the Arctic are excluded. Because most ichthyoplankton surveys concentrate on coastal areas, usually within 200 miles (370 km) of shore, this guide emphasizes coastal, nearshore species rather than strictly oceanic species. Taxa that usually do not produce planktonic early-life-history stages are generally excluded (e.g., Embiotocidae) as are strictly freshwater and estuarine species or spawners. Sources useful in identifying early-life-history stages of freshwater and estuarine species found adjacent to our study area include Wang (1981, 1986) and Auer (1982). In general, we have based coverage on species' likelihood of spawning in the Northeast Pacific Ocean rather than on the occurrence of adults. The geographic distribution of spawning is generally more restricted than the overall range of a species. Some low-latitude oceanic species (e.g., most members of the family Scombridae) which occur off Oregon and Washington are not included because they usually spawn much further south and their eggs and larvae do not occur in our area.

## Information sources

***Literature*** In producing this guide, we first compiled meristic and life history information from the literature. This was accomplished largely through a computer-based meristic information file generated by Kevin Howe at the University of Washington, and a compendium of life history information produced under the direction of Bruce Miller, University of Washington (Garrison and Miller 1982). Information from these sources was augmented and updated as it was incorporated in this guide. The meristic database was compiled by examining specimens and original radiographs, and from the literature (original descriptions, revisions, or general sources). When possible, counts are from the left side of the body. Since Garrison and Miller (1982) is not generally available, original sources cited by them are referred to in this guide. Published early-life-history information and illustrations were used when available, supplemented when possible by data from our field collections. Among the most useful published sources were Fitch and Lavenberg (1968, 1971, 1975), Miller and Lea (1972), Hart (1973), Eschmeyer et al. (1983), Moser et al. (1984b), Ozawa (1986a), and the many papers authored or co-authored by Ahlstrom, Moser, and Richardson (see Citations). Okiyama (1988) was received too late to be fully included in this guide.

***Specimens*** In addition to data gleaned from the literature, we have included some unpublished data and original illustrations obtained from specimens in our collections (Table 1). Specimens were from two major sources: (1) Investigations in the Kodiak Island region in the Gulf of Alaska conducted 1977-79, and (2) studies undertaken in cooperation with the U.S.S.R. beginning in 1980 to investigate the distribution and abundance of ichthyoplankton off northern California, Oregon, and Washington and in the Gulf of Alaska. Some specimens were also derived from work in the Bering Sea during 1971-72, 1976-78, and 1979. Dunn (1986) provides a list of ichthyoplankton surveys conducted by the NWAFC from which were obtained many of the specimens examined or illustrated for this guide. Occasionally specimens were obtained from other research collections or from rearing experiments conducted primarily by Jeffrey Marliave (Vancouver Public Aquarium) and David Misitano (NWAFC).

**Table 1**
**Collection data for original illustrations by Northwest and Alaska Fisheries Center (NWAFC).[a]**

| Taxon | SL (mm) | Cruise | Station number | Gear[b] | Date | Location or N° W° |
|---|---|---|---|---|---|---|
| *Thalassenchelys coheni* | 190.0 | | | | 15 02 84 | Puget Sound, WA[c] |
| *Clupea pallasi* | 10.4 | 4MF81 | G005A | 6B5 | 20 05 81 | 58°19.6′, 153°54.5′ |
| | 15.0 | SF7703 | P-4 | N | 05 04 77 | Str. Juan de Fuca, WA |
| | 19.0 | SF7603 | 13 | B | 18 05 76 | Str. Juan de Fuca, WA |
| | 23.8 | | | seine | 14 06 72 | |
| *Nansenia candida* | 5.1 | 1PO84 | G053A | 6B5 | 22 03 84 | 44°40.1′, 127°40.0′ |
| *Bathylagus milleri* | 15.0 | 2MF78 | G074A | TT | 02 07 78 | 57°07.0′, 151°01.0′ |
| *Bathylagus ochotensis* | 7.9 | 1EQ83 | G056A | B | 03 05 83 | 44°00.0′, 127°39.0′ |
| *Bathylagus pacificus* | 11.6 | 3MF79 | S25A | 6B5 | 17 06 79 | 54°05.2′, 170°59.0′ |
| | 17.6 | | | 6B5 | | Gulf of Alaska |
| *Macropinna microstoma* | 11.1 | 1PO84 | G066A | 6B5 | 24 03 84 | 43°40.0′, 124°37.0′ |
| *Danaphos oculatus* | 22.4 | | M161 | | 23 07 84 | 6 km W of Newport, OR |
| *Tactostoma macropus* | 14.3 | 1PO80 | G011A | 6B5 | 03 08 80 | 47°18.7′, 125°13.3′ |
| *Lampanyctus regalis* | 5.2 | 1PO80 | G061A | 6B5 | 12 08 80 | 38°00.0′, 125°42.5′ |
| *Diaphus theta* | 4.6 | K6703 | 50 | 1MN | 08 05 67 | 42°00.0′, 127°35.0′ |
| | 6.3 | 1PO80 | G085A | 6B5 | 20 08 80 | 40°20.0′, 125°20.0′ |
| | 16.0 | 1PO80 | G064A | 6B5 | 13 08 80 | 42°22.5′, 126°17.5′ |
| *Stenobrachius leucopsarus* | 4.9 | 2KE72 | G50A | 6B5 | 08 05 72 | 57°46.0′, 149°21.0′ |
| | 6.3 | 1PO84 | G112A | 6B5 | 02 04 84 | 40°40.1′, 126°47.0′ |
| | 18.0 | 4DI78 | G051A | TT1 | 13 04 78 | 55°26.8′, 153°53.7′ |
| *Melanonus zugmayeri* | 17.0 | Ocean ACRE-9 | 9-11 N | | 19 03 70 | 32°03.0′, 64°05.0′ |
| *Boreogadus saida* | 16.3 | *Glacier* (OCSEAP) | 11 | 6B5 | 11 08 76 | 70°47.0′, 162°14.0′ |
| *Gadus macrocephalus* | 4.1 | FOX86III (sample 111) | 166 | MOC | 18 05 86 | 57°40.6′, 155°09.8′ |
| *Theragra chalcogramma* | egg | composite | | | | Gulf of Alaska |
| | 3.5 | | | | — 04 82 | Gulf of Alaska[d] |
| Ophidiidae | 15.6 | 1EQ83 | G044A | 6B5 | 30 04 83 | 45°20.0′, 124°48.0′ |
| | 29.8 | 1EQ83 | G073A | 6B5 | 06 05 83 | 43°20.2′, 127°57.0′ |
| *Brosmophycis marginata* | 10.6 | | | | | Puget Sound[e] |
| *Gobiesox maeandricus* | 7.0 | | | | 12 02 76 | Brit. Columbia[f] |
| *Cololabis saira* | 6.7 | 1TK80 | G091 | N | 08 05 80 | 42°00.0′, 125°55.0′ |
| | 7.4 | 1DA81 | G039A | N | 02 11 81 | 45°37.0′, 124°52.0′ |
| *Trachipterus altivelis* | 9.4 | K6805 | 30 | 1MN | 23 10 68 | 45°44.0′, 124°38.0′ |
| | 24.0 | 1PO82 | G46A | 6B5 | 29 05 82 | 40°40.5′, 126°48.4′ |
| *Melamphaes* sp. | 3.7 | 1EQ83 | G034A | 6B5 | 28 04 83 | 46°00.0′, 128°31.0′ |
| *Sebastes brevispinis* | 4.6 | SEI77-9 | 21 | trawl | 12 07 77 | 58°28.3′, 139°30.0′ |
| *Sebastes caurinus* | 5.1 | | | | 05 07 77 | Reared by C. Mahnken[g] |
| *Sebastes jordani* | 4.6 | *Marathon* 85-1 | 229 | trawl | 25 05 85 | 48°09.6′, 125°05.3′ |
| *Sebastes melanops* | 4.0 | | | | 07 02 84 | Newport, OR[h] |
| *Sebastes polyspinis* | 6.1 | *Poseydon* 85-1 | | trawl | — 07 85 | Gulf of Alaska |
| *Sebastes rufus* | 36.0 | (Groundfish Comm. Invest.) | 8 | MWT | 04 06 85 | Farrallon Is., CA[i] |
| *Sebastes variegatus* | 4.6 | SEI77-9 | 21 | trawl | 12 07 77 | 58°28.3′, 139°30.0′ |
| *Sebastes zacentrus* | 4.7 | SEI77-9 | 33 | trawl | 16 07 77 | 59°40.1′, 143°03.5′ |
| *Sebastolobus* sp. | egg | 1PO81 | G065A | N | 22 05 81 | 43°40.0′, 125°01.4′ |

## Table 1 (continued)

| Taxon | SL (mm) | Cruise | Station number | Gear[b] | Date | Location or N° W° |
|---|---|---|---|---|---|---|
| *Anoplopoma fimbria* | 5.6 | 1PO84 | G019B | 6B5 | 15 03 84 | 46°40.5′, 124°59.0′ |
| | 8.8 | MF77B-6 | 83(1) | N | | 55°40.7′, 155°23.0′ |
| | 12.0 | MF77B-6 | 2(4) | N | 15 05 77 | 54°22.6′, 166°42.5′ |
| *Blepsias bilobus* | 12.4 | 3MF79 | V02A | N | 02 06 79 | 56°03.5′, 166°33.9′ |
| | 16.7 | 3MF79 | S12A | N | 06 06 79 | 56°35.7′, 165°54.3′ |
| | 24.8 | 3MF79 | S40A | N | 21 06 79 | 56°31.6′, 166°42.0′ |
| *Blepsias cirrhosus* | 11.5 | | | | — 04 80 | Friday Harbor, WA |
| | 16.8 | | | | — 04 80 | Friday Harbor, WA |
| *Chitonotus pugetensis* | 3.0 | | | | | Puget Sound, WA[j] |
| | 4.9 | | | | | Puget Sound, WA[j] |
| *Gymnocanthus* A | 9.6 | MF76A | B07 | 6B5 | 04 05 76 | 56°49.7′, 169°39.0′ |
| | 11.9 | MF76A | B17 | 6B5 | 20 05 76 | 54°42.3′, 165°25.9′ |
| *Hemilepidotus jordani* | 10.6 | 1SH81 | 066 | N | 19 03 81 | 57°03.0′, 155°53.0′ |
| | 18.4 | 3MF79 | V06A | N | 03 06 79 | 56°02.8′, 166°33.6′ |
| *Myoxocephalus* B | 9.1 | 1MD82 | G135A | 6B5 | 29 05 82 | 54°54.1′, 158°39.0′ |
| | 12.2 | 1MD82 | G135A | 6B5 | 29 05 82 | 54°54.1′, 158°39.0′ |
| *Myoxocephalus* G | 8.7 | 2KE72 | G39A | 6B5 | 06 05 72 | 57°33.0′, 152°06.0′ |
| *Nautichthys oculofasciatus* | 8.3 | | | | — 04 80 | Friday Harbor, WA |
| *Psychrolutes paradoxus* | 18.0 | | | | | Mukilteo, WA[j] |
| *Synchirus gilli* | 10.5 | | | | 15 05 79 | Neah Bay, WA[k] |
| | 16.8 | | | N | 16 05 79 | Neah Bay, WA[k] |
| *Agonidae* A | 4.7 | 1PO82 | G026A | 6B5 | 14 05 82 | 44°01.5′, 124°33.8′ |
| | 10.0 | | | | | Gulf of Alaska |
| *Agonomalus mozinoi* | 8.2 | MF77B-5 | 3(2) | 6B5 | 26 04 77 | 54°38.7′, 167°14.0′ |
| Cyclopteridae | 4.0 | 3MF81 | G058A | 5B5 | 01 05 81 | 56°55.9′, 154°55.8′ |
| *Nectoliparis pelagicus* | 7.9 | MF77B-6 | 55(1) | TT | 13 05 77 | 55°46.7′, 169°25.1′ |
| | 20.5 | MF77B-6 | 46(1) | 6B5 | 13 05 77 | 55°44.4′, 171°31.3′ |
| *Paraliparis* sp. | 28.5 | 4DI78 | 25 | 6B5 | 01 04 78 | 57°58.3′, 150°02.2′ |
| *Bathymaster* A | 9.0 | 2MF78 | G35A | 6B5 | 25 06 78 | 56°02.0′, 154°08.4′ |
| | 29.6 | MF77B-5 | 2(2) | N | 26 04 77 | 54°23.3′, 166°44.0′ |
| *Ronquilus jordani* | 7.7 | | 803E | | — 05 72 | Newport, OR |
| | 10.4 | | 912E | | — 05 72 | |
| *Anoplarchus purpurescens* | 6.1 | | | | | Puget Sound, WA[j] |
| | 9.0 | | | | | Puget Sound, WA[j] |
| | 12.0 | | | | | Puget Sound, WA[j] |
| | 12.0 | | | | | Puget Sound, WA[j] |
| | 12.0 | | | | | Puget Sound, WA[j] |
| *Bryozoichthys-Chirolophis* | 16.5 | MF76A | 10 | 6B5 | | 56°29.8′, 171°34.1′ |
| | 29.0 | MF77B-6 | 42 | N | 12 05 77 | 56°45.6′, 171°30.8′ |
| *Lumpenus sagitta* | 17.3 | 1MD82 | G028A | 6B5 | 08 04 82 | 56°40.0′, 155°27.0′ |
| | 35.1 | 4MF81 | G028A | 6B5 | 21 05 81 | 57°29.5′, 155°43.0′ |
| *Plectobranchus evides* | 9.2 | | 1143E | | 24 04 73 | Newport, OR |
| | 16.9 | | 1107E | | 20 04 73 | Newport, OR |
| | 31.3 | | 933E | | — 06 72 | Newport, OR |
| *Xiphister atropurpureus* | 8.0 | | | | 20 03 78 | Brit. Columbia[f] |
| *Delolepis gigantea* | 17.5 | 1MF80 | 34A ? | N | 27 03 80 | 57°52.4′, 154°38.9′ |
| *Lyconectes aleutensis* | 16.0 | MF77B-5 | 8(2) | N | 25 04 77 | 54°37.0′, 166°13.9′ |
| *Apodichthys flavidus* | ~15 | | | | | Brit. Columbia[f] |
| *Pholis* sp. | 9.2 | | | | | Brit. Columbia[f] |
| | 23.0 | 2MF78 | G034A | 6B5 | 25 06 78 | 56°33.3′, 154°51.2′ |
| *Anarhichas orientalis* | 21.0 | MF77B-5 | 8(2) | N | 25 04 77 | 54°37.0′, 166°13.9′ |
| *Ammodytes hexapterus* | 9.8 | 1SH81 | 177 | 6B5 | 22 04 81 | 55°54.0′, 156°36.0′ |
| | 32.3 | 1CH83 | S008A | N | 18 05 83 | 59°03.2′, 147°31.7′ |
| *Clevelandia ios* | 3.4 | | | TT | 04 05 82 | Bohom Bay, OR |
| | 15.0 | | | | 20 01 66 | Yaquina Bay, OR |
| *Coryphopterus nicholsi* | 4.4 | | | | 21 05 85 | Dabob Bay, WA[l] |
| *Lepidogobius lepidus* | 3.5 | | | TT (midwater) | | Yaquina Bay, OR |
| | 20.8 | | | 6 ft. otter trawl | 19 05 84 | 1 mi off Newport, OR |

## Table 1 (continued)

| Taxon | SL (mm) | Cruise | Station number | Gear[b] | Date | Location or N° W° |
|---|---|---|---|---|---|---|
| *Citharichthys sordidus* | 4.5 | 1EQ83 | G042A | | 30 04 83 | 45°20.0′, 124°06.0′ |
| | 7.0 | 1EQ83 | G042A | | 30 04 83 | 45°20.0′, 124°06.0′ |
| *Atheresthes stomias* | 10.0 | MF76A-III | 36 | 6B5 | 25 05 76 | 55°29.0′, 165°50.8′ |
| | 13.4 | DE-4 | 14K#2 | 6B5 | 25 07 71 | 56°45.0′, 168°05.0′ |
| | 25.6 | DE-4 | 16J | 6B5 | 02 08 71 | 56°15.0′, 171°21.0′ |
| *Glyptocephalus zachirus* | 11.5 | 2MF78 | G68A | TT | 01 07 78 | 56°17.3′, 152°55.8′ |
| *Hippoglossoides elassodon* | 5.0 | 2MF78 | G66A | TT | 30 06 78 | 55°59.7′, 153°33.2′ |
| | 7.9 | 2MF78 | G66A | TT | 30 06 78 | 55°59.7′, 153°33.2′ |
| | 15.0 | 3MF79 | S33A | 6B5 | 19 06 79 | 56°16.2′, 166°29.6′ |
| | 18.0 | SEI77-9 | 43 | 6B5 | 22 07 77 | 58°19.5′, 150°53.0′ |
| *Hippoglossus stenolepis* | 14.4 | 4DI78 | D45C | TT | 14 04 78 | 56°14.5′, 153°22.2′ |
| | 18.0 | 3MF81 | G012A | 6B5 | 27 04 81 | 57°57.0′, 154°13.3′ |
| *Lepidopsetta bilineata* | 4.3 | 4DI78 | G009A | 6B5 | 30 03 78 | 58°22.0′, 150°12.8′ |
| | 7.4 | 5TI79 | G024A | 6B5 | 19 05 79 | 56°23.7′, 155°45.0′ |
| | 10.8 | DE-4 | DE4#2 | 6B5 | 26 07 71 | 57°30.0′, 169°30.0′ |
| | 16.3 | 2MF78 | G023A | 6B5 | 24 06 78 | 57°19.5′, 152°23.9′ |
| *Lepidopsetta* 2 | 6.3 | 2MF78 | G044A | TT | 26 06 78 | 57°61.1′, 151°17.4′ |
| | 9.7 | 2MF78 | D01A | TT | 28 06 78 | 56°42.3′, 153°33.7′ |
| | 16.4 | SEI77-9 | 43 | 6B5 | 22 07 77 | 58°19.5′, 150°53.0′ |
| *Microstomus pacificus* | 15.0 | MF84-6 | B1 | 6B3 | 25 08 84 | Bering Sea[m] |
| | 26.0 | 1PO80 | G095A | 6B5 | 23 08 80 | 39°20.0′, 124°22.0′ |
| *Parophrys vetulus* | 4.5 | K6805 | 32 | 1MN | 23 10 68 | 45°44.0′, 124°07.0′ |
| | 10.0 | 6502 | 14F | | 14 05 65 | 46°10.0′, 124°42.0′ |
| | 17.5 | SF7702 | 2 | 6B3 | 23 02 77 | Str. Juan de Fuca, WA |
| *Platichthys stellatus* | 4.8 | 4MF81 | G029A | 6B5 | 21 05 81 | 57°24.8′, 155°37.0′ |
| | 6.6 | | | | 29 04 78 | Str. Juan de Fuca, WA |
| | 8.2 | | | | 29 04 78 | Str. Juan de Fuca, WA |
| | 9.0 | | | | 05 06 70 | Puget Sound, WA |
| *Pleuronectes quadrituberculatus* | 6.3 | 3MF79 | V014A | 6B5 | 05 06 79 | 57°02.9′, 165°02.8′ |
| | 7.8 | 3MF79 | V015A | 6B5 | 05 06 79 | 57°03.8′, 165°03.2′ |
| *Psettichthys melanostictus* | 2.5 | | | | 15 02 84 | Puget Sound, WA[j] |
| | 6.9 | | | | 07 03 84 | Puget Sound, WA[j] |
| | 8.1 | | | | 27 03 84 | Puget Sound, WA[j] |
| | 13.9 | | 591E | | — 06 — | Newport, OR |

[a]Several illustrations originally drawn for this publication and included in this table have already been published (e.g., Moser et al. 1984b, Kendall and Matarese 1987).

[b]Gear

6B5 = 60-cm bongo net, 0.505-mm mesh
6B3 = 60-cm bongo net, 0.333-mm mesh
B = 60-cm bongo net
MOC = MOCNESS net
1MN = 1-m net
MWT = midwater trawl
N = neuston net
TT = 1-m Tucker trawl

[c]Collected by Univ. Wash., Seattle, WA 98195.
[d]Reared by A.J. Paul, Univ. Alaska, Inst. Mar. Sci., Seward Mar. Cent., Seward, AK 99664.
[e]Reared by Steven Borton, formerly of Seattle Public Aquarium, Pier 59, Seattle, WA 98104.
[f]Reared by Jeffrey Marliave, Vancouver Public Aquarium, P.O. Box 3232, Vancouver, B.C., Canada V6B 3X8.
[g]Reared by Conrad Mahnken, NWAFC, Coastal Zone Estuarine Stud., Manchester Field Stn., P.O. Box 38, Manchester, WA 98353.
[h]Reared by George Boehlert, Southwest Fish. Cent., Honolulu Lab., Honolulu, HI 96822.
[i]Collected by Wayne Samiere, Southwest Fish. Cent., Tiburon Lab., Tiburon, CA 94920.
[j]Reared by David Misitano, NWAFC, Environ. Conserv. Div., Mukilteo Field Stn., P.O. Box 21, Mukilteo, WA 98272.
[k]Collected by Albert E. Giorgi, NWAFC, Coastal Zone Estuarine Stud., 2725 Montlake Blvd. E., Seattle, WA 98112.
[l]Collected by Bruce Frost, Univ. Wash., School Oceanogr., Seattle, WA 98195.
[m]Collected by Kevin Bailey, NWAFC, Resource Assess. Conserv. Eng., 7600 Sand Point Way N.E., Seattle, WA 98115-0070.

## Species list

The following list of species found in the study area was compiled from the literature. The order of higher taxa generally follows J. Nelson (1984); genera and species are listed alphabetically within families. The list is annotated with page numbers indicating where taxa are described in the guide. Page numbers are out of sequence in instances (e.g., myctophids, cottids) where taxa are grouped according to larval similarities, rather than alphabetically. Letters in place of page numbers indicate that a species is not given individual treatment for the following reasons: A = anadromous, D = direct development, F = freshwater spawner, S = spawns south of study area, U = inadequate early-life-history information available, V = viviparous. In these cases, available meristic and ecological information is given in appropriate higher-category (e.g., order, family) accounts.


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*Thecopterus aleuticus* U
*Thyriscus anoplus* U
*Triglops forficata* U
*Triglops jordani* U
*Triglops macellus* U
*Triglops metopias* U
*Triglops pingeli* U
*Triglops scepticus* U
*Zesticelus profundorum* U
Agonidae 456
*Agonomalus mozinoi* 458
*Agonopsis vulsa* U
*Agonus acipenserinus* U
*Agonus decagonus* U
*Anoplagonus inermis* U
*Aspidophoroides bartoni* U
*Aspidophoroides olriki* U
*Bathyagonus alascanus* U
*Bathyagonus infraspinatus* U
*Bathyagonus nigripinnis* U
*Bathyagonus pentacanthus* U
*Bothragonus swani* 460
*Hypsagonus quadricornis* U
*Ocella dodecaedron* U
*Ocella impi* U
*Ocella verrucosa* U
*Odontopyxis trispinosa* U
*Pallasina barbata* U
*Percis japonicus* U
*Sarritor frenatus* U
*Sarritor leptorhynchus* U
*Stellerina xyosterna* U
*Xeneretmus latifrons* 462
*Xeneretmus leiops* U
*Xeneretmus triacanthus* U
Cyclopteridae 465
Cyclopterinae 465
*Aptocyclus ventricosus* 466

*Cyclopteropsis phrynoides* U
*Eumicrotremus andriashevi* U
*Eumicrotremus barbatus* U
*Eumicrotremus birulai* U
*Eumicrotremus derjugini* U
*Eumicrotremus gyrinops* U
*Eumicrotremus orbis* 468
*Eumicrotremus soldatovi* U
*Eumicrotremus taranetzi* U
*Lethotremus muticus* U
*Pelagocyclus vitiazi* U
Liparidinae 470
*Acantholiparis caecus* U
*Acantholiparis opercularis* U
*Acantholiparis* sp. U
*Careproctus abbreviatus* U
*Careproctus attenuatus* U
*Careproctus bowersianus* U
*Careproctus cameliae* U
*Careproctus canus* U
*Careproctus colletti* U
*Careproctus cypselurus* U
*Careproctus ectenes* U
*Careproctus filamentosus* U
*Careproctus furcellus* U
*Careproctus gilberti* U
*Careproctus longifilis* U
*Careproctus melanurus* U
*Careproctus microstomus* U
*Careproctus mollis* U
*Careproctus opisthotremus* U
*Careproctus oregonensis* U
*Careproctus ostentum* U
*Careproctus ovigerum* U
*Careproctus pellucidus* U
*Careproctus phasma* U
*Careproctus pycnosoma* U
*Careproctus rastrinus* U
*Careproctus scottae* U
*Careproctus simus* U
*Careproctus* sp. U
*Careproctus spectrum* U
*Careproctus zachirus* U
*Crystallichthys cyclospilus* U
*Crystallichthys mirabilis* U
*Elassodiscus caudatus* U
*Elassodiscus tremebundus* U
*Gyrinichthys minytremus* U
*Liparis bristolensis* U
*Liparis callyodon* U
*Liparis catharus* U
*Liparis cyclopus* U
*Liparis dennyi* U
*Liparis florae* U
*Liparis fucensis* U
*Liparis gibbus* U
*Liparis grebnitzki* U
*Liparis mednius* U
*Liparis megacephalus* U
*Liparis micraspidophorus* U
*Liparis mucosus* U
*Liparis ochotensis* U
*Liparis pulchellus* U
*Liparis rutteri* U
*Liparis tunicatus* U
*Lipariscus nanus* U
*Nectoliparis pelagicus* 476
*Odontoliparis ferox* U
*Osteodiscus cascadiae* U
*Paraliparis cephalus* U
*Paraliparis dactylosus* U
*Paraliparis deani* 478
*Paraliparis holomelas* U
*Paraliparis latifrons* U
*Paraliparis megalopus* U
*Paraliparis melanobranchus* U
*Paraliparis mento* U
*Paraliparis paucidens* U
*Paraliparis pectoralis* U
*Paraliparis rosaceus* U
*Paraliparis ulochir* U
*Polypera beringiana* U
*Polypera greeni* U
*Rhinoliparis attenuatus* U
*Rhinoliparis barbulifer* 480
*Temnocora candida* U
Perciformes 483
Percoidei
Carangidae
*Naucrates ductor* 484
*Seriola lalandi* S
*Trachurus symmetricus* 486
Bramidae
*Brama japonicus* 488
*Taractes asper* U
Caristiidae
*Caristius macropus* 490
Sciaenidae
*Atractoscion nobilis* S
*Genyonemus lineatus* 492
*Seriphus politus* S
Pentacerotidae
*Pseudopentaceros* sp. 494
Embiotocidae
*Amphistichus koelzi* V
*Amphistichus rhodoterus* V
*Brachyistius frenatus* V
*Cymatogaster aggregata* V
*Embiotoca lateralis* V
*Hyperprosopon argenteum* V
*Hyperprosopon ellipticum* V
*Hypocritichthys analis* V
*Phanerodon furcatus* V
*Rhacochilus vacca* V
Zoarcoidei
Bathymasteridae 496
*Bathymaster caeruleofasciatus* U
*Bathymaster leurolepis* U
*Bathymaster signatus* U
*Ronquilus jordani* U
Zoarcidae 498
*Bothrocara brunneum* U
*Bothrocara hollandi* U
*Bothrocara molle* U

*Bothrocara pusillum* U
*Bothrocara remigerum* U
*Derepodichthys alepidotus* U
*Gymnelus bilabrus* U
*Gymnelus hemifasciatus* U
*Gymnelus popovi* U
*Gymnelus viridus* U
*Krusensterniella pavlovskii* U
*Lycenchelys altus* U
*Lycenchelys camchaticus* U
*Lycenchelys crotalinus* U
*Lycenchelys hippopotamus* U
*Lycenchelys jordani* U
*Lycenchelys longirostris* U
*Lycenchelys microporus* U
*Lycenchelys pliciferus* U
*Lycenchelys rassi* U
*Lycenchelys ratmanovi* U
*Lycenchelys roseus* U
*Lycenchelys volki* U
*Lycodapus derjugini* U
*Lycodapus dermatinus* U
*Lycodapus endemoscotus* U
*Lycodapus fierasfer* U
*Lycodapus leptus* U
*Lycodapus mandibularis* U
*Lycodapus pachysoma* U
*Lycodapus parviceps* U
*Lycodapus poecilis* U
*Lycodapus psarosomatus* U
*Lycodes brevipes* U
*Lycodes concolor* U
*Lycodes cortezianus* U
*Lycodes diapterus* U
*Lycodes mucosus* U
*Lycodes pacifica* U
*Lycodes palearis* U
*Lycodes raridens* U
*Lycodes turneri* U
*Lyconema barbatum* U
*Melanostigma pammelas* U
*Nalbantichthys elongatus* U
*Opaeophacus acrogeneius* U
*Pachycara bulbiceps* U
*Puzanovia rubra* U
*Taranetzella lycoderma* U
Stichaeidae 500
Stichaeinae
Stichaeini 500
*Eumesogrammus praecisus* U
*Stichaeus punctatus* U
Chirolophini 500
*Bryozoichthys lysimus* U
*Bryozoichthys marjorius* U
*Chirolophis decoratus* U
*Chirolophis nugator* U
*Chirolophis snyderi* U
*Chirolophis tarsodes* U
*Gymnoclinus cristulatus* U
Lumpeninae
Lumpenini 502
*Acantholumpenus mackayi* U
*Anisarchus medius* U
*Lumpenella longirostris* U
*Lumpenus fabricii* U
*Lumpenus maculatus* U
*Lumpenus medius* U
*Lumpenus sagitta* U
*Poroclinus rothrocki* U
Opisthocentrini 504
*Allolumpenus hypochromus* U
*Opisthocentrus ocellatus* 508
*Plectobranchus evides* 510
Xiphisterinae
Alectrini 504
*Alectridium aurantiacum* U
*Anoplarchus insignis* U
*Anoplarchus purpurescens* 512
Xiphisterini 504
*Cebidichthys violaceus* U
*Phytichthys chirus* 514
*Xiphister atropurpureus* 516
*Xiphister mucosus* 518
Cryptacanthodidae
*Delolepis gigantea* 520
*Lyconectes aleutensis* 520
Pholididae 522
*Apodichthys flavidus* U
*Pholis clemensi* U
*Pholis dolichogaster* U
*Pholis fasciata* U
*Pholis gilli* U
*Pholis laeta* U
*Pholis ornata* U
*Pholis schultzi* U
*Xererpes fucorum* U
Anarhichantidae
*Anarhichas orientalis* 524
*Anarrhichthys ocellatus* 526
Ptilichthyidae
*Ptilichthys goodei* 528
Zaproridae
*Zaprora silenus* 530
Scytalinidae
*Scytalina cerdale* U
Trachinoidei
Trichodontidae
*Arctoscopus japonicus* U
*Trichodon trichodon* 532
Blennioidei
Clinidae 535
*Gibbonsia metzi* U
*Gibbonsia montereyensis* U
*Heterostichus rostratus* 536
Icosteoidei
Icosteidae
*Icosteus aenigmaticus* 538
Ammodytoidei
Ammodytidae
*Ammodytes hexapterus* 540
Gobioidei
Gobiidae 543
*Clevelandia ios* 544
*Coryphopterus nicholsi* 546

*Lepidogobius lepidus* 548
Scombroidei
Trichiuridae 551
*Aphanopus carbo* U
*Benthodesmus elongatus* 552
*Benthodesmus tenuis* U
*Lepidopus fitchi* U
Scombridae
*Euthynnus pelamis* S
*Sarda chiliensis* S
*Scomber japonicus* 554
*Thunnus alalunga* S
*Thunnus albacares* S
*Thunnus obesus* S
*Thunnus thynnus* S
Acanthuroidei
Luvaridae*
*Luvarus imperialis* 556
Stromateoidei
Centrolophidae
*Icichthys lockingtoni* 558
Tetragonuridae
*Tetragonurus cuvieri* 560
Stromateidae
*Peprilus simillimus* 562
Pleuronectiformes 565
Paralichthyidae
*Citharichthys sordidus* 568
*Citharichthys stigmaeus* 570
*Paralichthys californicus* S
Pleuronectidae 573
*Acanthopsetta nadeshnyi* 574
*Atheresthes evermanni* 576
*Atheresthes stomias* 578
*Clidoderma asperrimum* U
*Embassichthys bathybius* 580
*Eopsetta jordani* 582
*Glyptocephalus stelleri* 584
*Glyptocephalus zachirus* 586
*Hippoglossoides elassodon* 588
*Hippoglossoides robustus* 590
*Hippoglossus stenolepis* 592
*Inopsetta ischrya* U
*Isopsetta isolepis* 594
*Lepidopsetta bilineata* 596
*Lepidopsetta* 2 599
*Limanda aspera* 602
*Limanda proboscidea* U
*Limanda sakhalinensis* U
*Liopsetta glacialis* 604
*Lyopsetta exilis* 606
*Microstomus pacificus* 608
*Parophrys vetulus* 610
*Platichthys stellatus* 612
*Pleuronectes quadrituberculatus* 614
*Pleuronichthys coenosus* 616
*Pleuronichthys decurrens* 618
*Psettichthys melanostictus* 620
*Reinhardtius hippoglossoides* 622
Cynoglossidae
*Symphurus atricauda* 624
Tetraodontiformes 627
Molidae
*Mola mola* 628

*Luvaridae is placed in the Scombroidei in J. Nelson (1984), but other studies (Leis and Richards 1984) have shown it belongs in the Acanthuroidei.

## Identifying fish eggs and larvae

This guide is designed primarily to assist in identifying eggs and larvae of fishes collected by sampling plankton. This process is usually divided into two main steps: 1) Sorting fish material out of the total plankton, and 2) identifying fish eggs and larvae of interest. Sorting procedures such as outlined in Kramer et al. (1972) are usually used. Matarese and Sandknop (1984) discuss identification of fish eggs, and Powles and Markle (1984) discuss identification of fish larvae. Eggs should be fixed and maintained in 3-5% buffered formalin, whereas larvae are better preserved if transferred to 70% ethanol after fixation in 3-5% buffered formalin (see Lavenberg et al. 1984). Identification is usually accomplished using a dissecting microscope at magnifications of 7 to 70×, with lighting from above and below a clear or frosted glass stage. A calibrated ocular micrometer is needed for various measurements of eggs and larvae. Specimens are frequently examined as whole mounts in their preservation medium in dishes or watch glasses (~50 mm diameter). Fine probes and forceps can be used carefully to manipulate the specimens. A piece of white paper inserted between the specimen dish and the stage makes pigment more readily visible.

Since the larvae, and certainly the eggs, do not look like their parents, different characters are required to identify them. In practice, it is often convenient to separate the eggs and larvae in a sample into similar-appearing types, before recording specific observations or trying to identify them. Generally, it is best to identify all specimens in a sample to the lowest taxonomic level possible, even if the collection was intended for certain target species; without careful examination, other species could be misidentified as those of a target species.

In addition to characters of the eggs and larvae themselves, clues to their identity are found in information such as geographic area, depth, and date of collection.

### Eggs

For pelagic fish eggs, the following identifying characters are recorded as known in this guide (see Matarese and Sandknop 1984 for more details): **Shape** (most are spherical, a few ellipsoidal); **size** (most are ~1 mm in diameter, range ~0.5-4.0 mm for pelagic eggs covered in this guide); **oil globules** (present in many species, vary in number and size); **yolk** (homogeneous or segmented); **chorion** (smooth in most, but sculptured in some); **perivitelline space** (narrow [<0.1 egg diameter] in many, but reaches one-half egg diameter in some); and **embryonic characters** (shape, pigment, gut length, early fin development, and myomere count of the embryo in late-stage eggs). Few taxonomic generalizations can be made for fish eggs; closely related species may have eggs that are as dissimilar as species in different orders (Table 2). However, the yolk is usually segmented in primitive teleosts (e.g., clupeiforms, anguilliforms, and salmoniforms) and homogeneous in more advanced forms. Also, oil globules are absent in pleuronectids covered in this guide.

### Larvae

Fish larvae possess a larger suite of characters than the eggs, and may undergo dramatic changes with development. To begin to identify a larval fish, the following should be noted: **Size** (NL or SL) and **stage of development** (e.g., preflexion, flexion, postflexion, transforming [Kendall et al. 1984]) as well as its **general appearance** (e.g., long and slender, short and deep bodied, lightly or heavily pigmented). Figure 2 illustrates anatomical features and measurements used to describe larvae. With practice, it is often possible to group larvae according to order or family (Fig. 3).

***Meristic characters*** Meristic characters are essential and should be determined, understanding that fin elements are gradually added during larval development. Myomeres are the first meristic character to stabilize, and the number usually reflects the number of adult vertebrae. The number of vertebrae varies among the fishes covered in this guide from <20 (molids) to >200 (e.g., most elopomorphs) (see Figure 4 where, for fishes occurring in the study area, vertebral counts are arranged by family in ascending order). Use of polarized light often facilitates counting myomeres. Myosepta are frequently more discernable than the myomeres, and if they are counted, one should be added to account for the myomeres anterior and posterior to the first and last myosepta.

The developing median fins contain several bits of taxonomic information. Dipping the larva in a potassium hydroxide solution and then in an Alizarin Red solution (see Hollister 1934 for solution recipes) for a few seconds, then rinsing and examining it in its preservative allows fin rays and head spines to be seen more clearly, since they stain red. However, this procedure may interfere with future attempts to clear and stain the larva. The principal caudal fin count is often an ordinal character (Table 2) and is very useful and relatively easy to determine in larvae, since it generally reaches its adult state shortly after flexion. The number, position, and order of development of the dorsal and anal fins, and their composition in terms of spines and soft rays, are important characters (Table 2). In several fishes (e.g., *Sebastes*), the final dorsal and anal spine develop first as soft rays, and change to spines during transformation. Thus, in late larvae, the median fins are different in the composition of spines and soft rays than in the adults. Fin rays that become elongate in larvae often develop precociously, otherwise second dorsal and anal soft rays generally develop concurrently when present. Spinous dorsal fins may develop before, concurrently, or after the second dorsal fin. When there is a gap between the spinous and soft-ray portions of the dorsal fin, spines generally develop after the soft rays.

In the sequence of paired fin development, the pectorals often develop early in the larval period, and the pelvics late. The pectoral fins form in the egg as larval pectoral fins, without fin rays. The fin rays generally develop much later in the larval stage. The length of the pectoral fin, as well as its number of rays, is a useful character. While the number of pectoral rays may vary within and among species in a genus, the pelvic fin position and formula are generally stable at a high level of classification (e.g., order; see Table 2). The pelvic fin is absent in anguilliforms and members of some other groups (e.g., zoarcids, ammodytids, and molids). In primitive fishes (e.g., clupeiforms, myctophiforms) it contains no spines, is abdominal, and generally contains more than five soft rays. In most perciforms and scorpaeniforms, the basic pelvic fin count is I,5, and it is thoracic in position. This count is reduced in some; notably in the northern Pacific, cottids often have fewer than five soft rays. The pelvic fin is modified into a sucking disc in gobiesociforms and in some cyclopterids.

Other meristic characters (e.g., gill rakers, secondary caudal fin rays, scales) develop too late to be generally useful in identifying larvae, but may be essential when working with pelagic juveniles.

*Pigmentation* Pigmentation available as taxonomic characters on larvae is limited to melanophores, since other pigment cells (e.g., xanthophores) do not retain their color in currently-used fixatives and preservatives. Melanophore patterns are very useful for identifying larval fishes. The relative size, position, and sometimes the number of melanophores in series should be noted. In some cases, pigmentation consists of a group of melanophores in a specific area; in others the pigmentation consists of an individual melanophore. Pigmentation generally changes as larvae develop. Movement of individual melanophores is rather limited, but addition or loss of melanophores is common. Usually preflexion larvae are less pigmented than later larvae, and late in the larval period, as transformation occurs, the larval pigment pattern is overgrown by the largely superficial pattern of the juvenile. Between the preflexion and transformation stages in most fish there is a definite larval pigment pattern which is relatively stable, and unique to a species in many cases. Although the position of melanophores is a species characteristic, the degree of contradiction seems to be physiologically moderated. Thus, larvae of the same species could have a different overall pigmented appearance, lighter or darker. Several species in the Northeast Pacific have heavily pigmented larvae, which are readily recognized in samples but may be confused with one another (Table 3, Fig. 5).

*Morphology* Larval shape can vary from stout and robust to quite slender and elongate (Table 2). Several fishes in the study area have elongate larvae which may be confused with one another (Table 4, Fig. 6). The ratio of body depth at the pectoral fin to standard length is usually sufficient to characterize overall body shape. The size and shape of the head and eye may also be important. The length of the gut, measured as the ratio of preanal to standard length, is quite useful. As with other characters, larval shape characters vary with development, so the size and stage of development should be noted when comparing shape of an unknown larva to illustrations and descriptions of known specimens.

Head spines, when present, may be more numerous and accentuated in larvae than in adults. Among Northeast Pacific fishes, larval head spines are most prevalent in cottids and scorpaenids, although they also occur in some members of groups such as perciforms and pleuronectids (Table 2).

Once the above data on an unknown specimen or group of similar specimens are assembled, actual identification becomes largely a process of eliminating species whose characters do not match the unknown specimen. Keys are not presented in this guide and generally do not work well with fish larvae, because the larvae change so much with development, and the larvae of all species in a study area are rarely known. With larvae, particularly, the first attempt should be to identify the unknown to order or family, based on meristic values, shape, and general appearance. Table 2 and the figures of larval representatives of various orders (Fig. 4) should be of assistance in this. Once an idea of the appropriate order/suborder is established, more detailed information can be obtained in the material at the beginning of each ordinal account, including general life-history characters, species represented in the study area, and meristic and early-life-history characters. Illustrations, meristics, and other information given in the individual taxon accounts in this guide should then be compared with the unknown specimens to find the most likely species. Differences between the unknown and described larvae should be noted. If an unknown specimen does not match any larval descriptions given here, check meristic tables of the most likely taxa to see if the unknown specimen fits a species whose larvae have not yet been described.

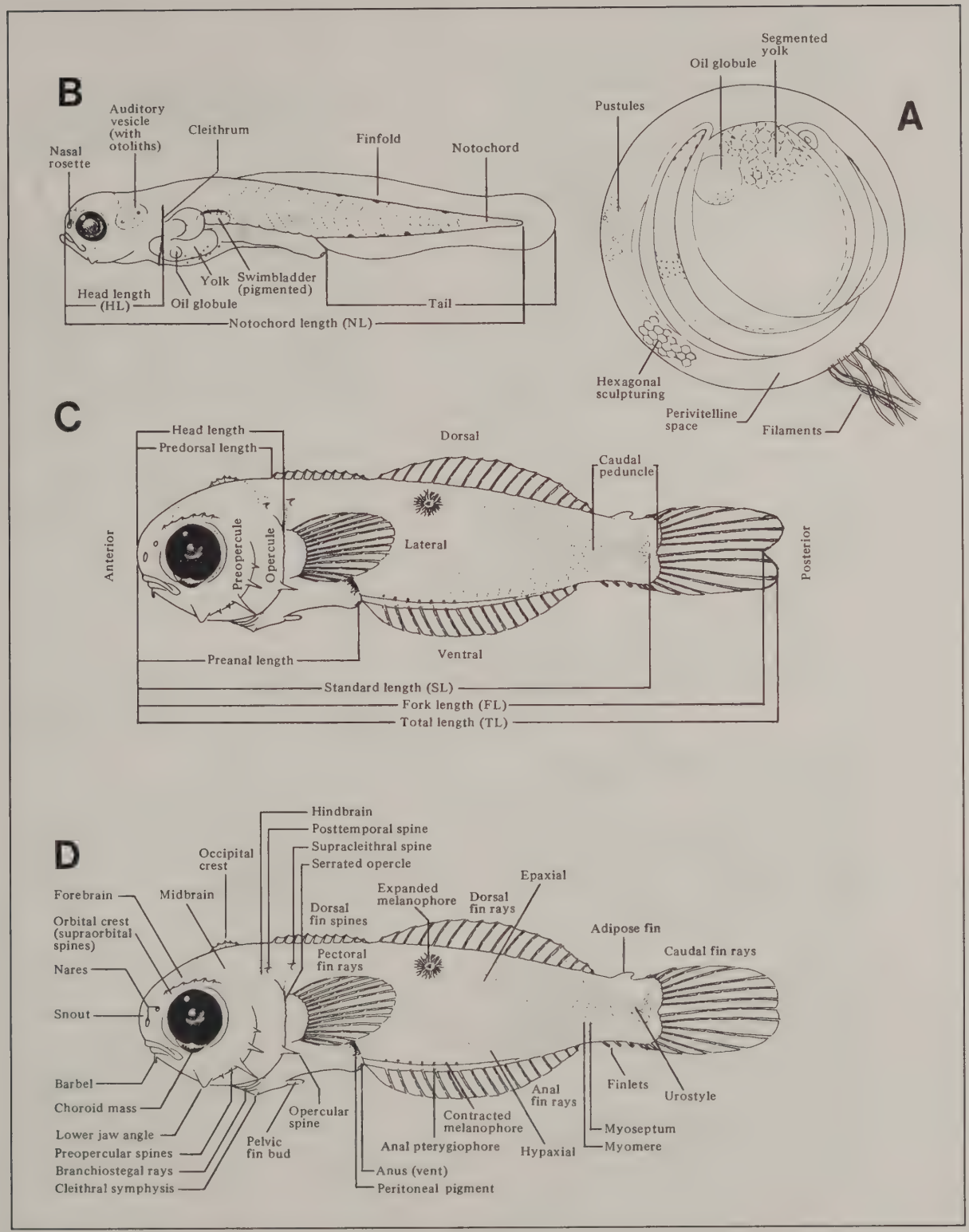



**Figure 2**

**Examples of features used to describe early stages of fishes: A, egg; B, preflexion larva; C, late larva showing base points for measurements; D, late larva showing morphological features (B-D, after Fahay 1983).**

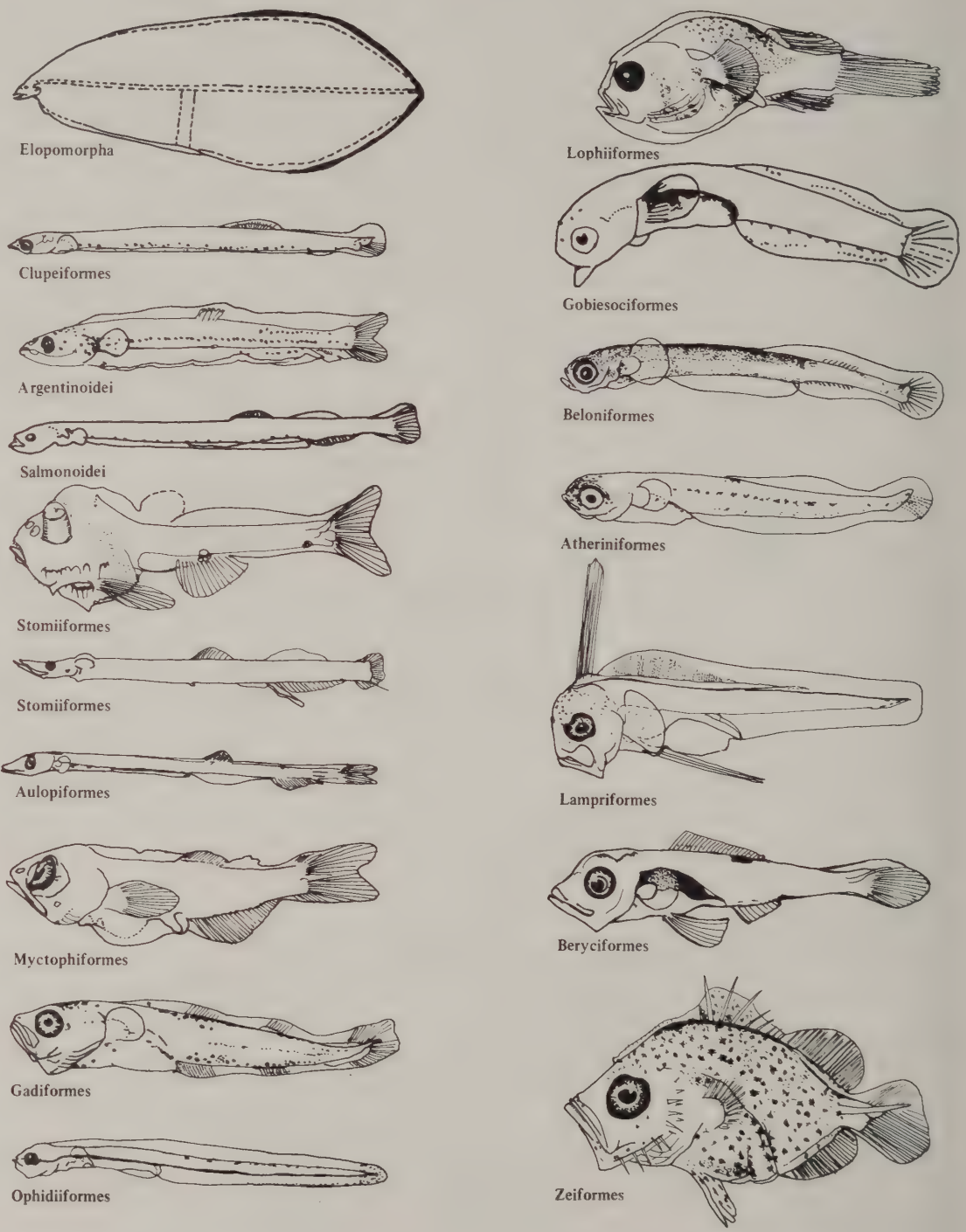



**Figure 3**

**Representative postflexion larvae of higher categories of fishes of the Northeast Pacific Ocean.**

Gasterosteiformes

Gasterosteiformes

Scorpaenoidei

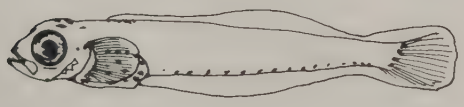
Anoplopomatoidei

Hexagrammoidei

Cottoidei

Percoidei

Zoarcoidei



Trachinoidei

Blennioidei

Icosteoidei

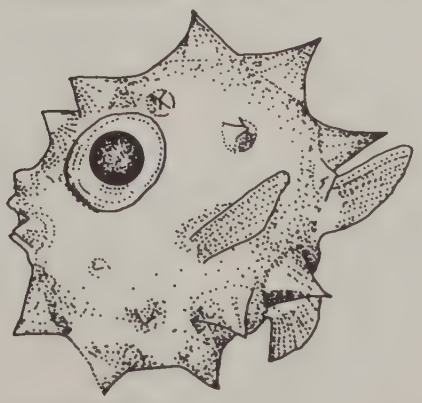
Ammodytoidei

Gobioidei

Scombroidei

Stromateoidei

Pleuronectiformes



Tetraodontiformes

**Figure 3 (continued)**

# Table 2

**Ordinal/subordinal egg, larval, and meristic characters of Northeast Pacific fishes (Ahlstrom and Moser 1976, Fahay 1983, Leis and Rennis 1983, in part).**

| Taxon | Families in study area | Eggs: Development site: Planktonic | Demersal | Internal | Shape: Spherical | Ellipsoidal | Chorion: Smooth | Sculptured | Yolk: Segmented | Homogeneous | Perivitelline space: Wide | Moderate | Narrow | Oil globule: Absent | 1 Present | >1 | Diameter (mm): <0.9 | 1.0-2.0 | >2.0 | Larvae: Shape: Elongate | Stocky | Preanal length (%SL): <50 | 50-75 | >75 | Gut shape: Straight | Coiled | Trailing | Eye shape: Round | Narrowed | Head spines: Absent | Present | Transformation: Marked | Gradual | Special juvenile: Present | Absent | Meristics: Fin characters: Spines: Present | Absent | Pelvic fin: Position: Abdominal | Thoracic | Jugular | Formula | No. dorsal fins: One | Two | Adipose fin: Present | Absent | Vertebrae | Principal caudal fin rays: Upper | Lower | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Notacanthiformes/ Anguilliformes | 9 | X | | | X | | X | | X | | X | | | X | X | X | | | X | X | | | X | X | | X | | X | X | X | | | X | | | X | X | | | | | X | | | 68-750 | 0-9 | 0-7 | 0-16 |
| Clupeiformes | 2 | X | X[a] | | X | X | X | | X | | X | X | X | X | X | | | X | | X | | | X | X | | | X | | X | | X | | | X | | | X | | | 6-9 | X | | X | | 43-57 | 10 | 9 | 19 |
| Salmoniformes | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Argentinoidei | 5 | X | | | X | | | X | X | | | X | X | | X | X | | X | X | X | | | X | X | | | X | X | X | | X | X | X | X | | X | | X | | 6-12 | X | | X | X | 34-84 | 10 | 9 | 19 |
| Salmonoidei | 2 | | X | | X | | X | | X | | | X | | | | X | | X | X | X | | | X | X | | | X | | X | | X | | X | | | X | | X | | 8-11 | X | | X | | 54-75 | 10 | 9 | 19 |
| Stomiiformes | 6 | X | | | X | | X | X | X | | X | X | X | X | X | | | X | X | X | X | | X | X | | | X | X | X | | X | | | | | X | | X | | 6-17 | X | | X | X | 35-83 | 10 | 9 | 19 |
| Aulopiformes | 7 | X | | | X | | | X | | | X | | | X | | | | X | | X | | | X | | | X | X | X | | | X | | X | | | X | | X | | 8-12 | X | | X | X | 48-87 | 10 | 9 | 19 |
| Myctophiformes | 2 | X | | | X | | X | X | X | | | | X | X | X | | | X | | X | X | | X | | X | | X | X | | X | X | X | X | X | | | X | | | 7-10 | X | | X | | 29-42 | 10 | 9 | 19 |
| Gadiformes | 5 | X | X | | X | | X | X[b] | | X | | | X | X | X | X | | X | X | X | X | | X | | X | | X | | X | | X | | X | | X | X | | X | | 0-17 | X | X[c] | | X | 48-64;84-86 | 4-6[d] | 2-4[d] | 6-10[d] |
| Ophidiiformes | 3 | Unknown | | | | | | | | | | | | | | | | | | X | | X | | | X | | | X | | X | | X | | | X | | | | | | I,1-2 | X | | X | | 60-81 | 4 | 5 | 9 |
| Lophiiformes | 2 | X | | | X | | X | | X | X | | | X | X | X | | X | | | | X | | X | | X | | X | | X | | X | | | X | X | | X | | | I,4 | X | | X | | 32-36 | ? | ? | 14 |
| Gobiesociformes | 1 | | X | | | X | X | | | X | | | X | X | | | | X | | X | | | X | | X | | X | | X | | X | | | X | | | X | | | 6 | X | | X | | 62-69 | 7 | 8 | 15 |
| Beloniformes[f] | 1 | X | X | | | X | | X | | X | | | X | X | | | | X | | X | | | X | | X | | X | | X | | X | | | X | | X | | | | I,5-6 | | X | | X | 44-52 | 9 | 8 | 17 |
| Atheriniformes | 1 | | X | | X | | | X | | X | | | X | | | X | | X | X | X | | X | | X | | X | | X | | X | | | X | | X | X | | | | 6-7 | X | | X | | 43-46;90-94 | ? | ? | ? |
| Lampriformes | 2 | X | | | X | | X | | X | | X | | | X | | | | | X | X | X | X | | X | | X | | X | | X | | | X | | X | X | | | | 0-I,6-8 | X | | X | | 23-52 | 10 | 9 | 19 |
| Beryciformes | 5 | X | | | X | | X | | X | | | X | | | X | | X | | | X | X | X | | X | | X | | X | X | X | X | X | | X | X | | | | I,6 | X | | X | | 39 | 6 | 7 | 13 |
| Zeiformes | 1 | X | | | X | | | | X | | | | | X | | | X | | | | X | | X | | X | | X | | | X | | X | | X | X | | | | I,1 or 4 | X | X[g] | | X | 30-64 | 6-7 | 6 | 12-13 |
| Gasterosteiformes | 3 | | X | X | X | | X | | X | | | X | | | | X | | X | | X | | X | X | | X | | X | X | | X | | X | | X | X | X | X | X | | | | | | | | | | |
| Scorpaeniformes | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Scorpaenoidei | 1 | | | X | X | X | X | | X | | | X | | | X | X | X | | X | X | | X | X | X | | X | | X | | X | X | X | | X | | | | | | | 1,5 | X | | X | | 26-31 | 7 | 7 | 14 |
| Anoplopomatoidei | 1 | X | | | X | | X | | X | | | X | X | | | | | X | | X | | | X | X | | X | | X | | X | | X | | X | | | | | | | 1,5 | | X | | X | 61-66 | 7 | 7 | 14 |
| Hexagrammoidei | 1 | | X | | X | | X | | X | | | X | | | X | X | | X | X | X | | X | X | | X | | X | | X | X | | X | | X | | | | | | | 1,5 | X | | X | | 36-63 | 7-8 | 6-11 | 13-19 |
| Cottoidei | 3[h] | | X | | X | | X | X | X | | | X | | | X | X | | X | X | X | X | X | | X | | X | | X | | X | X | X | | X | | | X[i] | | X | | 1,2-5[i] | X | X | | X | 25-71 | 6 | 5-7 | 11-13 |
| Perciformes | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Percoidei | 6 | X | | | X | | X | | X[j] | X | | X | | | X | | | X | | X | X | X | | X | | X | | X | X | | X | X | X | X | | | | | | | 1,5 | X | | X | | 23-41 | 9 | 8 | 17 |
| Zoarcoidei | 9 | | X | | X | | X | | | X | | X | | | X | | | X | X | X | | X | X | | X | | X | | X | | X | | X | X | | X | | | X | X | 0-1,0-5 | X | X | | X | 49-150;221-250 | ? | ? | 12-15 |
| Trachinoidei | 1 | | X | | X | | X | | | X | | X | | | X | | | | X | X | | X | | X | | X | | X | | X | | X | | X | X | | | | | | 1,5 | | X | | X | 44-47 | ? | ? | 13 |
| Blennioidei | 1 | | X | | X | | | X[l] | | X | | X | | | X | X | | | X | X | | X | | X | | X | | X | | X | | X | | X | X | | | | | | 1,3 | X | | X | | 55-58 | 9 | 8 | 17 |
| Icostoidei | 1 | X | | | X | | X | | | X | | | X | | X | | | X | X | X | | X | | X | | X | | X | | X | | X | | X | X | | | | X[k] | X | | | | I,4[k] | X | | X | 66-68 | 9 | 8 | 17 |
| Ammodytoidei | 1 | | X | | X | | X | | | X | | X | | | X | | X | | | X | | X | | X | | X | | X | | X | | X | | X | | X | X | | | | | | | X | | X | 65-70 | 9 | 8 | 17 |
| Gobioidei | 1 | | X | | | X | | X | | X | | | X | | | X | X | X | | X | | X | | X | | X | | X | | X | | X | | X | | | | | | | 5-6 | | X | | X | 26-38 | ? | ? | 17 |
| Scombroidei | 2 | X | | | X | | X | | X | | | X | | | X | | | X | | X | X | | X | | | X | | X | | X | | X | | X | | | | | | | I,1;I,5 | X | X | | X | 22-23;30-32;148-150 | 9 | 8 | 17 |
| Acanthuroidei | 1 | Unknown | | | | | | | | | | | | | | | | | | X | X | | X | | | X | | X | | X | | X | | X | | | X | X | | | 1,4[k] | | X | | X | 22-23 | ? | ? | 16 |
| Stromateoidei | 3 | X | | | X | | X | | X | | | X | | X | | | | X | | X | X | X | X | | X | | X | | X | | X | | X | | X | | X[l] | | | 1,5 | X | | | X | 28-31;52-62 | 9 | 8 | 17 |
| Pleuronectiformes | 3 | X | X[m] | | X | | X | X[n] | | X | X[o] | X | X[p] | X | | | X | X | X | X | X | | X | | X | | X | X | X | | X | | X | | X | | | X | | | 4-6 | X | | X | | 35-66 | 9-12[q] | 8-11[q] | 17-24[q] |
| Tetraodontiformes | 1 | X | | | X | | X | | X | | X | X | | | X | | | X | | X | X | | | | X | | X | | X | | X | | X | | X | X | | | | | | X | | X | | 17-18 | | | 15[r] |

[a] *Clupea pallasi* eggs demersal.
[b] Macrouridae eggs sculptured.
[c] Three dorsal fins in Gadidae.
[d] Macrouridae lack caudal fins.
[e] Pelvic fin modified into a disc.
[f] J. Nelson (1984) places scomberesocids within the Cyprinodontiformes.
[g] Dorsal spines isolated from soft-rayed dorsal fin.
[h] J. Nelson (1984) considers Psychrolutidae a separate family; we include it in Cottidae.
[i] Pelvic fin absent or modified into a disc in Cyclopteridae.
[j] *Trachurus* yolk segmented.
[k] Pelvic fin present only in larvae.
[l] Pelvic fin absent in *Peprilus*.
[m] *Lepidopsetta bilineata* only species with demersal egg.
[n] *Pleuronichthys* eggs have hexagonal sculpturing.
[o] *Hippoglossoides elassodon* and *H. robustus* only species with wide perivitelline space.
[p] Pleuronectidae eggs have no oil globule.
[q] Total caudal fin rays.
[r] *Mola mola* has a pseudocaudal fin (see Tyler 1980).

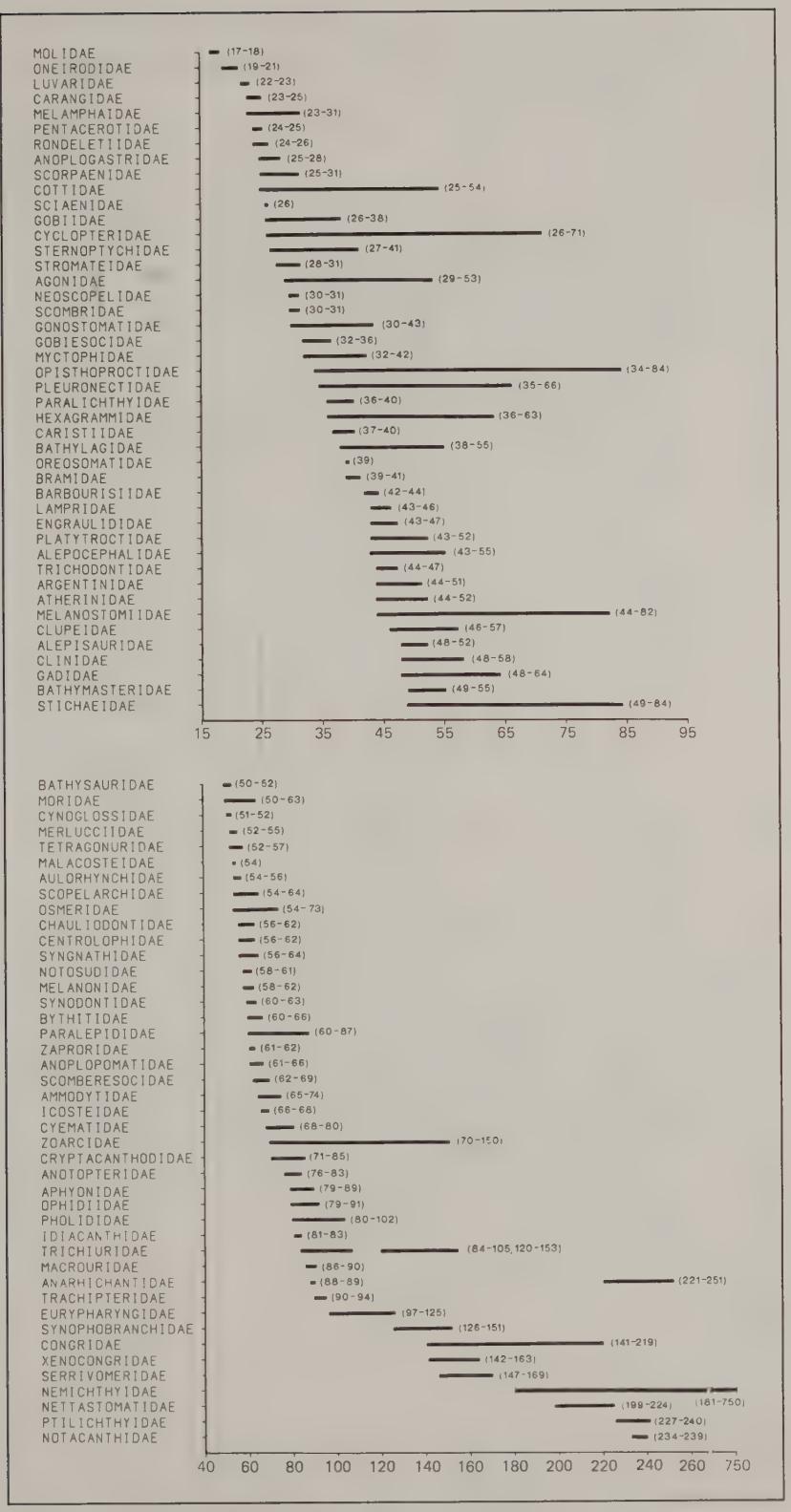



**Figure 4**

**Ranges of total vertebral counts for families in the study area.**

## Table 3

**Distinguishing features of some commonly collected heavily pigmented larvae.***

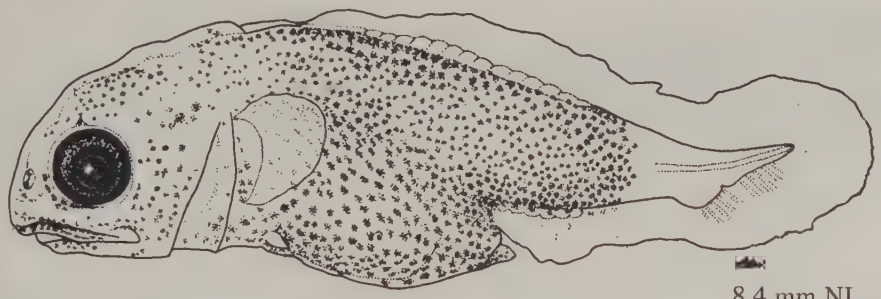
| Taxon | Distribution | Total vertebrae | Description of pigment | Other diagnostic features | Page reference |
|---|---|---|---|---|---|
| **Myomeres 25-50** | | | | | |
| *Rhamphocottus richardsoni* | SSC-Bering Sea | 26-28 | Small spots, densely distributed on head, gut, and 3/4 body; absent on peduncle and tail | Subterminal mouth, deep body; after flexion head spines and prickles by 9-10 mm | 366 |
| *Myoxocephalus* G | Wash.-Bering Sea | 34-37 | Spots concentrated dorsally on head and gut, and over anterior 1/2 body; absent over gut | Head spines develop during flexion | 400 |
| *Hemilepidotus* spp. | SSC-SE Alaska | 35-39 | Spots widely distributed on head, gut, and body | Head spines develop during flexion | 372 |
| *Scorpaenichthys marmoratus* | SSC-SE Alaska | 35-37 | Dense, uniformly distributed spots over head, gut, and 3/4 body; absent on tail | Head bumps and preopercular spines develop after flexion; preanal finfold | 382 |
| *Blepsias* spp. | Cent. Calif.-Bering Sea | 37-39 | Dense, large spots evenly concentrated over dorsal head, gut, and >3/4 body; absent on tail tip | Head spines and bumps develop during flexion | 448 |
| *Pleuronichthys* spp. | SSC-Bering Sea | 37-41 | Dense spots concentrated over head, gut, and >3/4 body; dorsal and anal finfold | Slender body with wide finfolds | 616 |
| *Radulinus* spp. | SSC-Gulf of Alaska | 38-40 | Widely distributed over lateral gut surface and almost 3/4 body | Preopercular spines not prominent, gut coiled | 406 |
| *Hemitripterus villosus* | Gulf of Alaska-Bering Sea | 39-41 | Spots evenly distributed to 3/4 body and into dorsal and anal finfold | Large size at development | 452 |
| *Nautichthys oculofasciatus* | Cent. Calif.-Bering Sea | 40-41 | Large, widely distributed spots to 3/4 body; dorsal and anal finfold pigment at midbody | Long, pigmented precocious pectorals; head spines, bumps, ridges develop after flexion | 454 |
| **Myomeres >50** | | | | | |
| *Hexagrammos* spp./ *Pleurogrammus monopterygius* | S. Calif.-Bering Sea | 50-63 | Widely distributed on dorsal head and gut, above and below notochord | Gut length <50% SL | 348 |
| *Ophiodon elongatus* | SSC-Gulf of Alaska | 56-59 | Widely distributed on dorsal head and gut, more concentrated on dorso- and ventrolateral surface; chin and isthmus | Pointed snout and large terminal mouth | 346 |
| *Zaprora silenus* | Cent. Calif.-Bering Sea | 61-62 | Small spots densely concentrated over entire body, except ventrally on gut, dorsal finfold, and posterior edge of gill cover; lightly on caudal peduncle and anal finfold | Large size at development | 530 |
| *Anoplopoma fimbria* | SSC-Bering Sea | 61-66 | Widely distributed over >3/4 body | >15 mm, pectoral fins long, pigmented; gut length >50% SL; anus curves ventrad | 338 |
| *Cololabis saira* | SSC-Bering Sea | 62-69 | Small spots densely concentrated, ventral tailtip without pigment | Long preanal finfold | 236 |
| *Lyconectes aleutensis* | N. Calif.-Bering Sea | 73-75 | Heavily concentrated over >3/4 body, isthmus; lighter over gut and absent on peduncle | Large size at development | 520 |
| *Delolepis gigantea* | N. Calif.-Bering Sea | 81-83 | Widely distributed to 3/4 body, absent over gut and isthmus | Large size at development | 520 |

*Other heavily pigmented larvae that may be less frequently encountered include the following species:

*Anarhichas orientalis* (p. 524)
*Naucrates ductor* (p. 484)
*Peprilus simillimus* (p. 562)
*Oxylebius pictus* (p. 342)
*Zaniolepis* (p. 344)

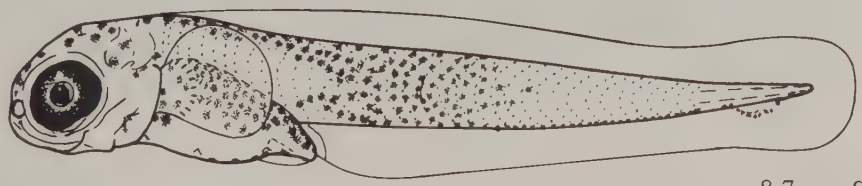
## HEAVILY PIGMENTED LARVAE (MYOMERES 25–50)

**A** *Rhamphocottus richardsoni*



8.4 mm NL

**B** *Myoxocephalus* G



8.7 mm SL

**C** *Hemilepidotus* spp. *(Hemilepidotus spinosus)*

8.9 mm NL

Figures A, C, Richardson and Washington 1980; B, NWAFC original (B. Vinter).

**Figure 5**

**Commonly collected heavily pigmented larvae with 25-50 myomeres (A-I), and >50 myomeres (J-P).**

## HEAVILY PIGMENTED LARVAE (MYOMERES 25–50)

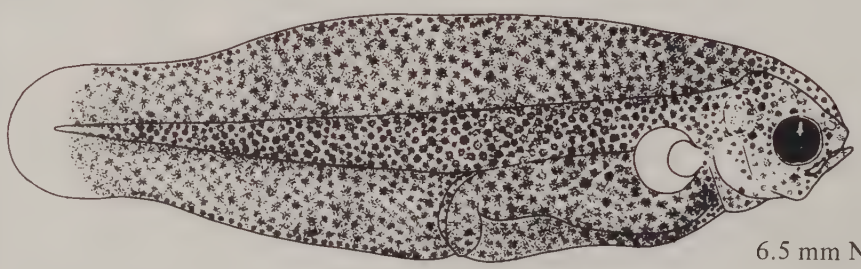
**D** *Scorpaenichthys marmoratus*

8.6 mm NL

**E** *Blepsias* spp. *(Blepsias cirrhosus)*

11.5 mm SL

**F** *Pleuronichthys* spp. *(Pleuronichthys decurrens)*

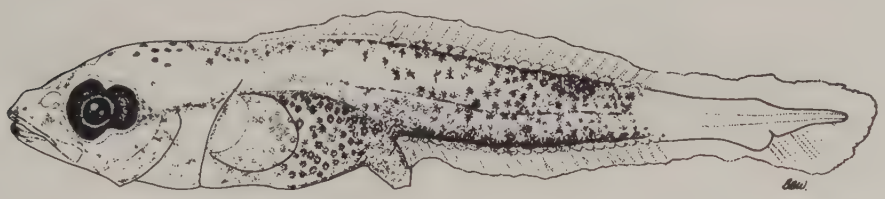


6.5 mm NL

Figure D,.Richardson and Washington 1980; E, NWAFC original (B. Vinter); F, Sumida et al. 1979.

**Figure 5 (continued)**

**G** *Radulinus* spp. *(Radulinus asprellus)*

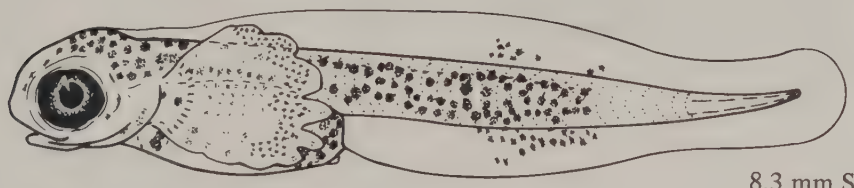


9.6 mm NL

**H** *Hemitripterus villosus*

14.4 mm SL

**I** *Nautichthys oculofasciatus*



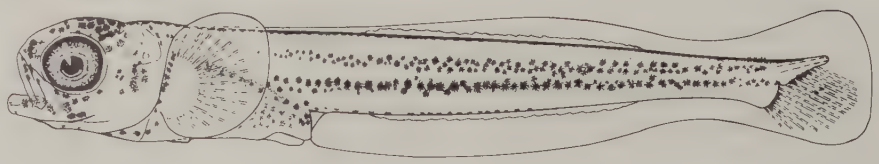
8.3 mm SL

Figure G, Richardson and Washington 1980; H, Okiyama and Sando 1976; I, NWAFC original (B. Vinter).

**Figure 5 (continued)**

## HEAVILY PIGMENTED LARVAE (MYOMERES > 50)

**J** *Hexagrammos* spp. *(Hexagrammos octogrammus)*

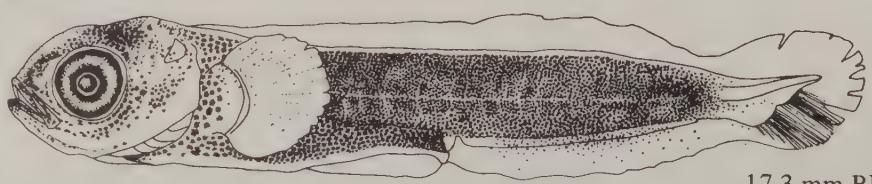


15.0 mm SL

**K** *Ophiodon elongatus*

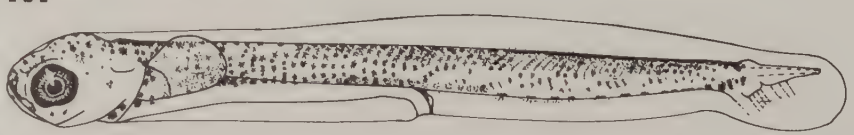
12.2 mm SL

**L** *Zaprora silenus*



17.3 mm BL

**M** *Anoplopoma fimbria*

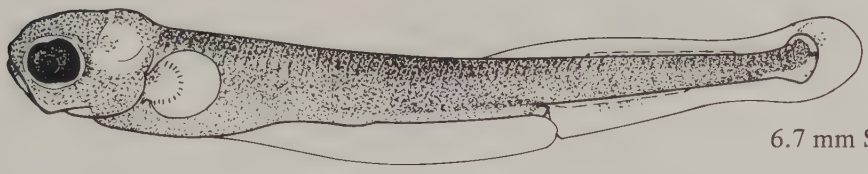


12.0 mm SL

Figures J–K, Kendall and Vinter 1984; L, Haryu and Nishiyama 1981; M, NWAFC original (B. Vinter).

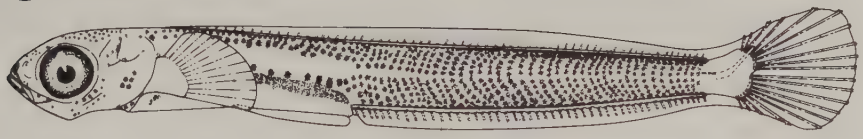
**Figure 5 (continued)**

**N** *Cololabis saira*



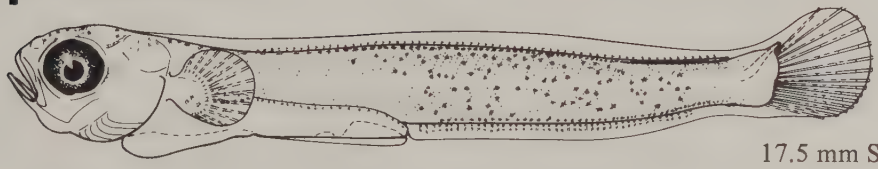
6.7 mm SL

**O** *Lyconectes aleutensis*



16.5 mm SL

**P** *Delolepis gigantea*



17.5 mm SL

Figures N–P, NWAFC originals (B. Vinter).

**Figure 5 (continued)**

## Table 4

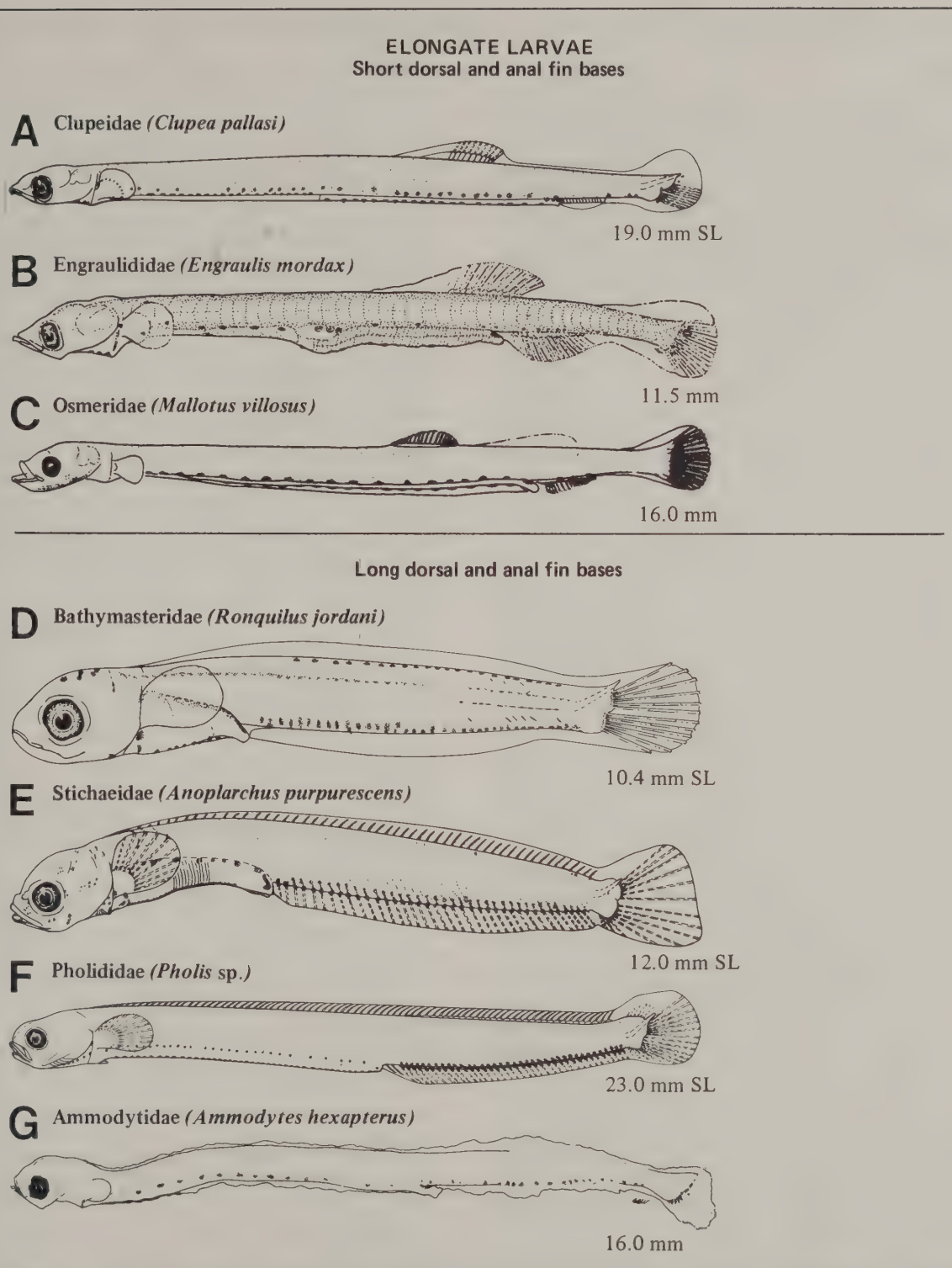
**Comparison of selected diagnostic characters of some commonly collected families with similar-looking elongate larvae.**

| Taxon | Myomeres: Preanal | Myomeres: Postanal | Myomeres: Total | Number between dorsal fin insertion and anal fin origin[a] (flexion stage) | Preanal length | Presence of adipose fin | Diagnostic pigment | Page reference |
|---|---|---|---|---|---|---|---|---|
| **Short dorsal and anal fin bases** | | | | | | | | |
| Clupeidae | 28-32 | 19-23 | 46-57 | 6-8 | 80% | None | Gut | 44 |
| Engraulididae | 24-26 | 19-21 | 43-47 | 0-2 | 67-75% | None | Isthmus, gut | 48 |
| Osmeridae[b] | — | — | 54-73 | 9-11 | 80% | Yes | Single row pvm;[c] ventral gut midline | 79 |
| **Long dorsal and anal fin bases** | | | | | | | | |
| Bathymasteridae | 13-16 | 34-39 | 49-55 | Overlaps | <50% | None | Urostyle or slash-like pigment along posterior hypaxial and epaxial myomeres | 496 |
| Stichaeidae | 14-31 | 34-59 | 50-83 | Overlaps | <50% | None | Gut, anus, pvm[c] | 500 |
| Pholididae | — | — | 80-102 | Overlaps | >50% | None | Gut, pvm[c] | 522 |
| Ammodytidae | 40-47 | 23-25 | 65-74 | Overlaps | 60% | None | Double row pvm[c] | 540 |

[a] The number of myomeres between dorsal and anal fins has been used as a taxonomic character in clupeiform larvae of certain size classes. During transformation the position of the gut and median fins shifts forward relative to myomere number (for more details, see McGowan and Berry 1984).

[b] Based on larvae of *Mallotus villosus* (except for total myomere count); other osmerids, as yet unidentified to species, are similar.

[c] pvm = postanal ventral midline melanophores.




Figures A, D–F, NWAFC originals (B. Vinter); B, Kramer and Ahlstrom 1968; C, Fahay 1983 (after Templeman 1948); G, Stevens et al. 1984.

**Figure 6**
**Commonly collected elongate larvae.**

## Format

This laboratory guide has been designed to be practical and easy to use. Only information deemed necessary for accurate and timely identification has been included. A two-page format is provided for each taxon where sufficient early-life-history information exists. The left page includes pertinent information for identification and the right page includes illustrations, usually with notations indicating important diagnostic features. The left page is divided into two columns: Information on meristic characters and life history features is presented on the left, and developmental information on the right. Blanks within the format indicate that particular information was not available (e.g., egg size, fecundity), to point out gaps in knowledge, and allow researchers to insert new information as it becomes available. The family name appears at the top of each page for quick reference. The phylogenetic sequence generally follows J. Nelson (1984) unless otherwise indicated. Species names along with their authorities appear at the upper right corner of the left page, and common names (from Robins et al. 1980, Hubbs et al. 1979, Shiino 1976, and others) are included at the upper left corner of the right page. Nomenclature generally follows Robins et al. (1980) and Steyskal (1980) unless a more recent revision is available (usually from Moser et al. 1984b). Exceptions are noted in the text.

For taxa treated at the species level, available illustrations are arranged on the right-hand page as follows: Late-stage egg is in the upper right-hand corner, and order of larvae is shown (top to bottom) as yolksac, preflexion, flexion, postflexion, and either a transforming juvenile or special prejuvenile stage. Blank spaces indicate that stages were not available for illustration. When necessary for identification purposes, additional illustrations such as dorsal and ventral views are provided. Most illustrations were compiled from the literature; Moser et al. (1984b) provided over 100 illustrations. In a few cases, illustrations from the literature were redrawn, modified, or corrected; when this occurred, it is indicated. In addition to the published illustrations, original illustrations of 124 fish eggs and fish larvae by Beverly Vinter are included. Collection data are provided for original illustrations (Table 1).

Introductory sections are provided for each order and for taxa (usually genera or families) with difficult identification problems or for taxa that contain numerous similar species (e.g., Cottidae and *Sebastes*). Important diagnostic features are summarized, and, in some cases, tables are provided to aid in identification. In the Northeast Pacific Ocean, early-life-history stages of many species are either undescribed, incompletely described, or without adequate illustrations. For these taxa, identification material is provided at the lowest taxonomic level possible, usually family level (e.g., Osmeridae) or generic level (e.g., *Cyclothone*). Family level descriptions include a summary of available early and general life-history information, tables of meristic characters, and brief accounts of early-life-history characters from closely related taxa described from other geographic areas. For taxa where no early-life-history data are available (e.g., Cetomimoidei), life history summaries and meristic data are provided.

## Meristics

Data summaries of meristic structures, except those for the caudal fin or from recently completed research, are from the NWAFC meristic database. The range (high and low value) and mode are presented for each entry. Ranges reported here generally represent the most extreme values ever recorded; in many cases, these values are not likely to be observed. These values may have been seen on specimens collected outside our study area. Thus, in using this guide more emphasis should be placed on the reported modal values. An "X" appears when data are unavailable. For fin ray counts, R = rays (soft rays) and S = spines; for gill raker counts, U = upper and L = lower. In addition to pelvic fin-ray counts, fin position is given. Position is indicated by the following descriptors: Abdominal, thoracic, jugular, absent, or modified (e.g., pelvic disc in cyclopterids). The total vertebral count given may not equal the sum of the precaudal and caudal vertebral counts in some cases, since these counts may have originated from different sources.

Data for caudal fin-ray counts have been gleaned from published material, as well as from original observations. Caudal fin-ray counts are reported in the following sequence: Upper secondary, upper principal + lower principal, lower secondary, with ranges for each when available. Total caudal fin rays or total principal caudal fin rays are reported if no other data are available. Blanks in the caudal field indicate that no data are available.

For some taxa, it was necessary to forego the standard meristic format in order to present the data or provide additional information (e.g., members of the family Gadidae have three dorsal fins and two anal fins). Departures from the standard format are either explained on the page where they occur or in introductory sections preceding species descriptions for certain taxa.

## General life history

Life history data are provided as ancillary information which may aid in identification of eggs and larvae. These data were extracted from Garrison and Miller (1982) and supplemented by the general literature and original, unpublished material.

Geographic ranges are from the NWAFC meristic database and the literature. Allen and Smith (1988) provided a significant amount of new information. Range information is restricted primarily to the study area. Thus, the limits of the southern range beyond the California-Mexico border, the northern range beyond the Arctic to the north and east, and the western range beyond the Bering Sea are not specified.

The following general locations are used to approximate geographic range within the study area (abbreviations in parentheses are used hereafter in the text when necessary):

South of southern California (SSC)
Southern California, 32-34°N (S. Calif. or S. California)
Central California, 34-38°N (Cent. Calif. or Cent. California)
Northern California, 38-42° N (N. Calif. or N. California)
Oregon, 42-46°N
Washington, 46-48°30′N (Wash.)
British Columbia, 48°30′-55°N (Brit. Col.)
Southeastern Alaska, 55-59°N (SE Alaska)
Gulf of Alaska, 54-60°N
Aleutian Islands, 51-55°N (Aleutian Is.)
Bering Sea, 54-66°N
Chukchi Sea, north of 66°N
Arctic

In addition to geographic range, general ecological descriptors are incorporated in the NWAFC meristic database. The following descriptors are used.

**Pelagic environment**

***Nearshore shelf pelagic:*** Extends from the shore seaward to include waters overlying an ocean bottom <200 m. Equivalent to the neritic province of Hedgpeth (1957) and other authors.

***Oceanic:*** Waters overlying an ocean bottom >200 m. The following subdivisions based on water depth are used: Epipelagic 0-200 m; Mesopelagic 200-1000 m; Bathypelagic >1000 m.

**Benthic environment**

***Intertidal, nearshore:*** Extends from high tide to low tide. Equivalent to the littoral province of many authors.

***Nearshore shelf demersal:*** All bottom from low tide to 200 m (= epibenthal in text). Equivalent to the sublittoral zone of Hedgpeth (1957) and other authors.

***Mesobenthal:*** Deep sea beyond the continental shelf at depths of 200-500 m. Lowest part of the shelf and upper part of continental slope (Fedorov 1973).

***Bathybenthal:*** Deep sea along the continental slope at depths of 500-2500 m. Middle and lower sections of continental slope (Fedorov 1973).

***Freshwater or anadromous:*** Generally the mouth and lower reaches of rivers and streams.

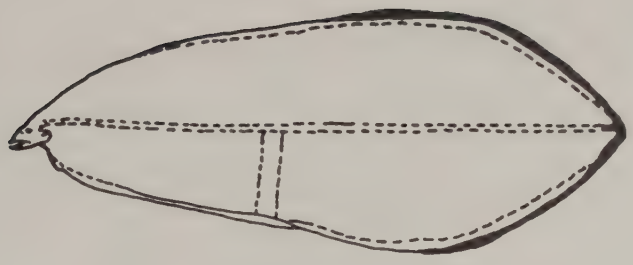
Other information under **Life History** includes reproductive mode (e.g., viviparous, ovoviviparous, oviparous) and indicates whether eggs and larvae are pelagic or demersal. Data on spawning are divided into four categories: Season, area, mode, and migration. Spawning often varies among geographic regions and populations, so care has been taken to provide as much specific geographic information as available. Fecundity values are given as counts of ripening eggs in individual females: Total ranges or (in a few cases) as a function of length in the form $F = aL^b$. Ages at first maturity and longevity values were extracted from the general literature. If available, age/length differences between sexes are noted.

## Early life history

Egg and oil globule diameter measurements in millimeters are usually given as ranges (high and low values) with modal values as available in parentheses after the range. Precision varies among literature sources, but specimens used for original measurements were measured to the nearest 0.1 mm. Egg diameters on the illustrations are as they were given in the source. Incubation time, when available, is given in number of days to hatching for a specific temperature (°C). When describing embryonic pigment patterns, emphasis was placed on those characteristics which aid in identification. Diagnostic characters usually provide a summary of important features and comparisons with similar fish eggs.

Figure 2 provides examples of features used to describe and identify early stages of fishes. Original measurements of larvae are in millimeters and given in standard length (SL). Some measurements extracted from the literature were given as body length (BL), notochord length (NL), total length (TL), head length (HL), or percentages of these. Preanal length is usually expressed as a percentage of SL. If specific values are not available, preanal lengths are given as <50% SL, 50-75% SL, or >75% SL. Definitions for developmental stages are from Ahlstrom et al. (1976) and Kendall et al. (1984). Transformation is defined as acquisition of the adult complement of fin rays, and in some taxa this is accompanied by squamation. Sequence of fin development is usually described as the order in which fin rays accept alizarin stain, inferring ossification. For some taxa the sequence is determined by completion of the ossification of a fin element rather than the initiation of ossification (e.g., G.D. Johnson 1984); this is noted in the text. When three or more fins develop simultaneously, semicolons are used to separate the sequence of formation of one or more fins (e.g., dorsal; anal; caudal, pectoral, and pelvic). Otherwise, commas are used to separate fins developing individually in sequence (e.g., dorsal, anal, caudal, pectoral, and pelvic). Precocious fin development is usually noted. When describing pigment, those melanophores or patterns of melanophores important in identifying the taxon are stressed. Generally only melanophores are mentioned, since other pigment is not visible in formalin-preserved specimens. The general appearance, shape, and relative size of melanophores or groups of melanophores are indicated by imprecise descriptors such as spot, patch, or blotch. Diagnostic pigment characteristics are also indicated directly on the illustration page. The description of pigment is often brief and in telegraphic style and is not meant to be a substitute for more detailed discussions available in complete early-life-history descriptions. References are provided when more complete early-life-history descriptions are available. Under **Diagnostic Characters**, a brief summary of key features is provided which may help to distinguish a larval specimen from other similar larvae in either closely related taxa or from morphologically similar groups. When possible, comparative information is included in tables and is cross-referenced.

Data from the files of the late E.H. Ahlstrom are footnoted as "E.H. Ahlstrom notes." These files contain original lecture notes for classes conducted on ichthyoplankton taxonomy between 1971 and 1977, early-life-history data for most orders of fishes, and notes on teleost caudal fins. The files were made available to Kendall & Matarese by H. Geoffrey Moser (Southwest Fish. Cent., Natl. Mar. Fish. Serv., NOAA), as authors contributing to *Ontogeny and Systematics of Fishes* (Moser et al. 1984b).

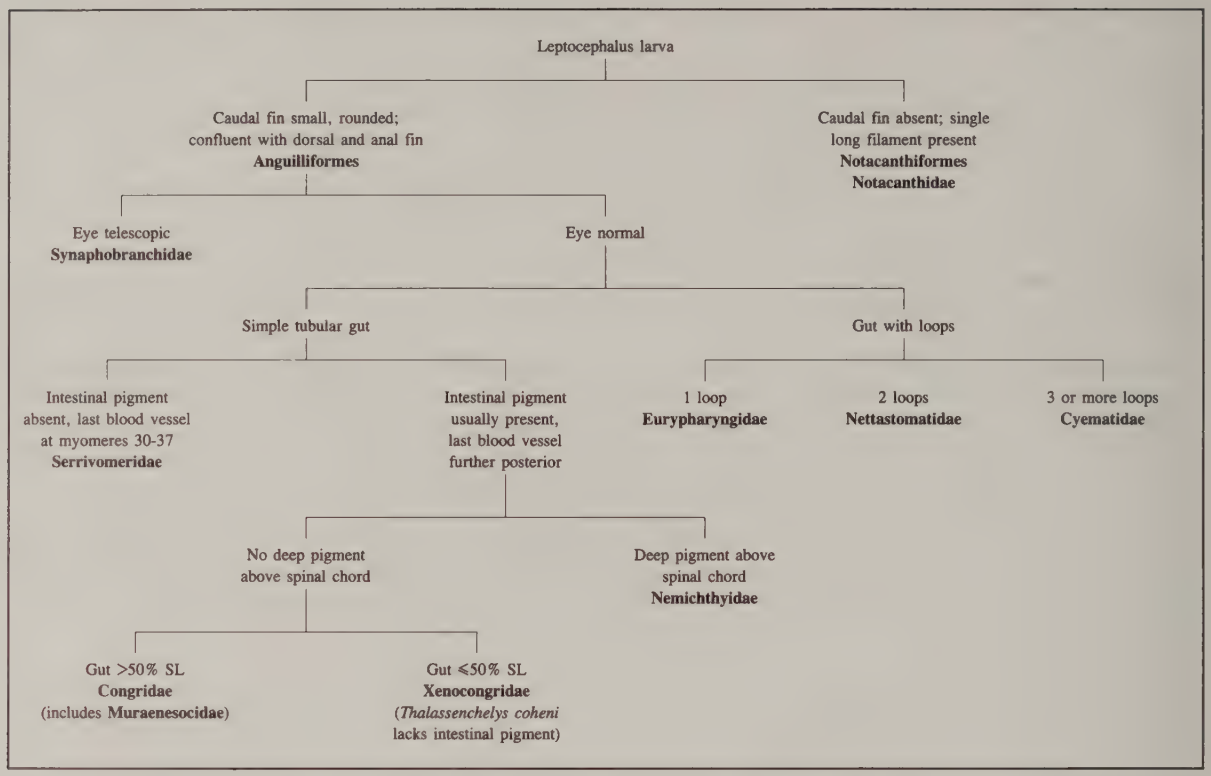


## Elopomorpha: Notacanthiformes
## Anguilliformes

The notacanthiform fishes (spiny eels) and anguilliform fishes (true eels) generally occur worldwide. The spiny eels are primarily a deep-sea group and are distinguished from the true eels by a number of characters including the absence or reduction of the caudal fin, the presence of well developed pelvic fins and fin spines, a short dorsal fin, and the presence in larvae of a thin postcaudal filament. According to Castle (1984), the Notacanthiformes consist of 3 families, 6 genera, and about 22 species; the Anguilliformes, a much larger order, include 21 families, 153 genera, and about 720 species.

The early life history of eels has been studied for many years primarily due to the presence of a distinctive leptocephalus larval phase, but many species remain inadequately known. Eggs are generally large, pelagic, possess segmented yolks, and have one or more oil globules. Although few larvae have been collected, at least 12 taxa from at least 9 families are thought to occur in the study area. Since early life histories are incomplete, this section (except for the nemichthyids) will be described by family.

Families in study area: **Notacanthidae**
**Xenocongridae**
**Nemichthyidae**
**Cyematidae**
**Synaphobranchidae**
**Nettastomatidae**
**Congridae**
**Serrivomeridae**




**Key to elopomorph leptocephali in the Northeast Pacific (after Smith 1979 and Fahay 1983, in part).**

**Table 5**
**Meristic characters of superorder Elopomorpha.**

| Taxon | Distribution | Vertebrae: Precaudal | Vertebrae: Caudal (Total) | Fins: Dorsal | Fins: Anal | Fins: Pectoral | Fins: Pelvic | Fins: Caudal |
|---|---|---|---|---|---|---|---|---|
| **Notacanthiformes** | | | | | | | | |
| Notacanthidae | | | (234-244) | | | | | |
| *Notacanthus chemnitzi* | Cent. Calif.[a]-Oregon | 47-55 | (234-239) | VII-X or IX,2-3 | XI-XXV, 115-132 | 10-17 | I-IV, 6-10 | Absent |
| *Polyacanthonotus challengeri* | Oregon-Bering Sea | | (242-244) | XXXII-XXXV | 161-162 | 12-13 | I, 8 | Reduced |
| **Anguilliformes** | | | | | | | | |
| Xenocongridae | | | (97-163) | | | | | |
| *Thalassenchelys coheni* | | 67-74 | 83-92 (142-163) | 280-350 | 218-260 | Absent | Absent | Absent |
| Nemichthyidae | | | (170-400+) | | | | | |
| *Avocettina infans* | SSC-Aleutian Is. | | (181-201) | 300-350 | 265-270 | | Absent | Reduced |
| *Nemichthys larseni* | SSC-Oregon | 79-84 | (400-750) | | | 10-12 | Absent | |
| *Nemichthys scolopaceus* | SSC-Aleutian Is. | | (293-750) | 307-450 | 312-454 | 10-14 | Absent | Reduced |
| Cyematidae | | | (74-108) | | | | | |
| *Cyema atrum* | SSC-Oregon | 38-43 | (74- 80) | 79-83 | 72-86 | 12-15 | Absent | 5 |
| Synaphobranchidae | | | (126-172) | | | | | |
| *Histiobranchus bathybius* | Bering Sea | | (126-151) | 265-302 | 188-203 | 15-17 | Absent | 18 |
| *Nettastomatidae* | | | (186-290) | | | | | |
| *Venefica* sp. A | Cent. Calif.-Wash. | | (199-224) | 310+ | 325 | | Absent | 12 |
| Congridae | | | (120-261) | | | | | |
| *Xenomystax atrarius* | SSC-Brit. Col. | 50-57 | 107-123 (141-219) | 253-292 | 189-214 | 11-14 | Absent | 7-8 |
| Serrivomeridae | | | (137-170) | | | | | |
| *Serrivomer jesperseni* | Brit. Col. | 89-125 | (147-169) | 141-161 | 127-161 | 6-7 | Absent | Reduced (6 principal) |
| Eurypharyngidae | | | (97-125) | | | | | |
| *Eurypharynx pelecanoides* | N. Calif.[b] | | (97-125) | 155-196 | 118-147 | 11 | Absent | Absent in adult |

[a]Lea and Rosenblatt (1987)
[b]One specimen collected off northern California.

## Anguilliformes

Primary characters used in identifying anguilliform leptocephali are the following (Ref: E.H. Ahlstrom notes, Castle 1984, Fahay 1983, Smith 1979):

**Body shape** May vary from slender to deep-bodied, and the tail may be tapered or rounded.

**Head characteristics** Size of the head relative to the body may vary; also important are head shape (blunt, sharp, or elongate), snout shape, nasal organ (size and position), eyes (round, narrow, or telescopic), and teeth (presence/absence, fanglike if present).

**Number of myomeres** Usually 100-250; exceptions include *Cyema* (<100) and *Nemichthys* (>750). Preanal and predorsal counts are also useful.

**Gut characteristics** Gut may be a simple straight tube or more complex with loops or swellings. Relative length of gut can range from <50% SL to >90% SL, although most eels have gut lengths between 50-70% SL.

**Position of vertical blood vessels** Variation in the position of the last blood vessel.

**Pigmentation** General body pigment may be located above/below the gut, along body midline, above/below notochord internally, or along the dorsal body margin. Pigment may be in the form of fine stippling or large stellate melanophores (blotches). Head pigment also varies.

**Size at transformation** Maximum size before transformation can vary from <100 mm SL (most families) to ~400 mm SL (nemichthyids).

**Fins** Dorsal and anal fins are confluent with the caudal fin, caudal fin is usually markedly reduced with 10 or fewer rays (about 5-11 with highest numbers in synaphobranchids); pectoral fin is moderate, reduced, or lacking, and fin rays usually form late, i.e., after the leptocephalus stage. Pelvic fin is absent.

**Notacanthidae (234-244 myomeres)*** *Notacanthus chemnitzi* and *Polyacanthonotus challengeri* both occur in the study area but their early life histories are unknown, as is the case of most notacanthids. *Leptocephalus giganteus* (identity unknown) from outside the study area is presented for comparison only. Notacanthid larvae are easily separable from larvae of true eels. Among the most notable characters are the following: Greatly elongate shape, thin postcaudal filament, and pigment which occurs in a ventral series.

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**Xenocongridae (97-163 myomeres)** *Thalassenchelys coheni* (142-163) may or may not belong with the xenocongrids. These larvae are quite unusual, with a short, deep body, rounded tail, and lack of pigment. They appear to be widely distributed in the northeastern Pacific from Washington to south of southern California.

---

**Cyematidae (74-80 myomeres, most 74-78)** *Cyema atrum* larvae are identified by their deep body shape, pointed head and tail, 3-4 gut loops on posterior half of gut, and low myomere count. Pigment is scattered over the lateral body surface, on the snout and lower jaw, and along the gut, especially on the loops. Other general features include gut length ~67% SL and dorsal fin origin approximately above anus. Size at transformation is 60-70 mm SL.

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**Synaphobranchidae (subfamily Synaphobranchinae) (126-151 myomeres)** Synaphobranchinae are represented in the Northeast Pacific by *Histiobranchus bathybius* but their larvae are unknown. Larvae in other members of the subfamily are identified by their telescopic eye, general lack of pigment, and the broad white stripe formed by an opaque central area of myomeres around the notochord. The body is moderately elongate and the head is short and pointed. The dorsal fin origin is anterior to the anus. The gut is usually relatively simple, unpigmented, and about 75% SL. Some taxa have loops in the gut. Ventral pigment is lacking, and lateral pigment is restricted to the postanal body. Some genera have a prominent pigment spot laterally, near the level of the anus. Size at transformation is 130-170 mm SL.

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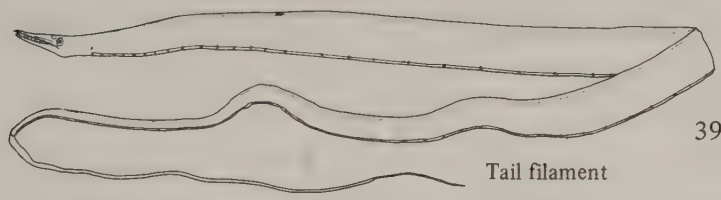
*Vertebral range is given for taxa in the study area. When no data are available, the range of counts for family is given (Table 5).

Ref: E.H. Ahlstrom notes, Castle 1984, Castle and Raju 1975, Fahay 1983.

NOTACANTHIDAE

A

*Leptocephalus giganteus*



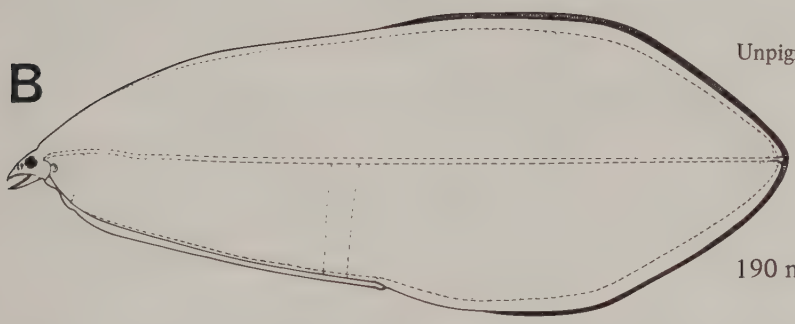
390 mm TL

Tail filament

XENOCONGRIDAE

*Thalassenchelys coheni*

B



Unpigmented

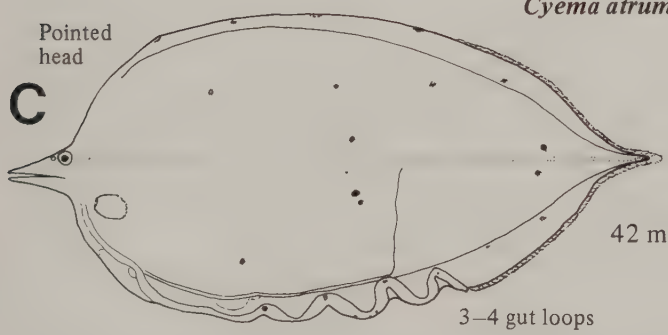
190 mm SL

CYEMATIDAE

*Cyema atrum*

Pointed head

C



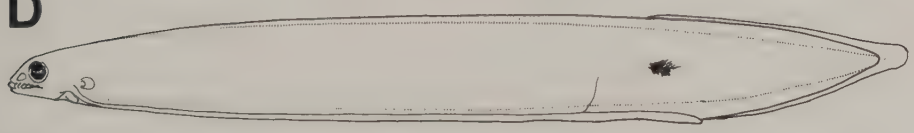
42 mm SL

3–4 gut loops

SYNAPHOBRANCHIDAE

*Synaphobranchus* sp.

D



E

Telescopic eye

29 mm SL

**Unidentified synaphobranchid**

Figures A, D, Castle 1984; B, NWAFC original (B. Vinter); C, E, Smith 1984.

**Nettastomatidae (186-290 myomeres)** Nettastomatids are represented in the Northeast Pacific by *Venefica* sp., but their larvae are unknown. Larvae in the family are identified by their gut characteristics (presence of two loops and gut length <50% SL) and moderately long head. The body is deep to elongate and the tail is pointed. The dorsal fin origin is posterior to the head but well anterior, at myomeres 11-12. Ventral and lateral pigment is variable. Size at transformation is also variable but occurs between 120 and 200 mm SL.

---

**Congridae (141-219 myomeres)** Congrids are represented in the area by *Xenomystax atrarius*, a member of the subfamily Muraenesocinae (larvae unknown). *Xenomystax* is closely related to *Paraxenomystax* (Smith 1979). Members of this subfamily are sometimes considered part of a separate family. Their larvae have a moderately elongate body with the gut length about 75% SL. Pigment occurs on the head, widely spaced along the throat to anus, and below the lateral midline in the form of a row of large spots. Size at transformation is probably similar to the congrids with most at 100 mm SL but some up to 200-300 mm SL.

---

**Serrivomeridae (147-169 myomeres)** *Serrivomer jesperseni* larvae are identified by a head shape that is sharp and slightly concave, pointed tail, simple gut with a length of ~75% SL, and a small nasal organ near the eye. The dorsal fin origin is located anterior to the anus. The last blood vessel occurs between myomeres 30-37. Pigment may be located variously over the lateral body surface, but ventral pigment is lacking. Other pigment appears along the dorsal and anal fin bases and in a cluster on the orbit above the eye. Size at transformation is 60 mm SL.

---

**Eurypharyngidae (97-125 myomeres)** *Eurypharynx* larvae are identified by their short, deep head and body, gut about 50-67% SL with one loop posteriorly, and pointed tail. Ventral pigment is limited to the gut loop. Size at transformation is 30-40 mm SL.

---

Ref: E.H. Ahlstrom notes, Castle 1984, Fahay 1983, Smith 1979.

NETTASTOMATIDAE

*Saurenchelys* sp.

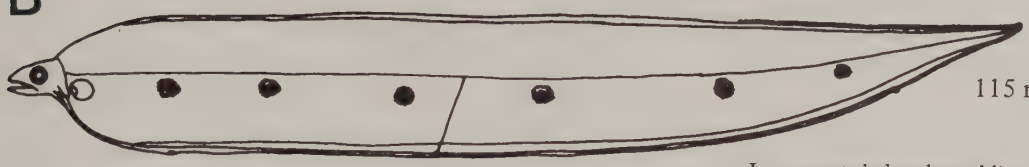
A

Two gut loops

CONGRIDAE

*Paraxenomystax* sp.

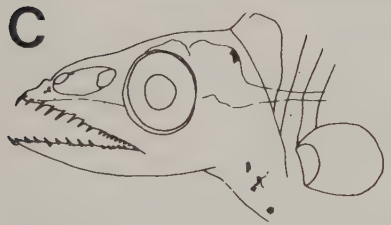
B

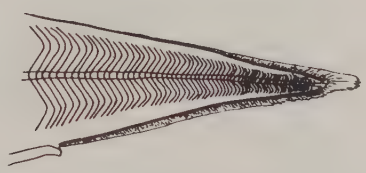


115 mm SL

Large spots below lateral line

C



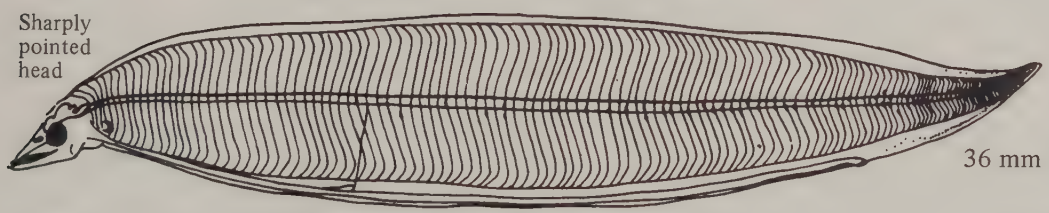


SERRIVOMERIDAE

*Serrivomer jesperseni*

D

Sharply pointed head



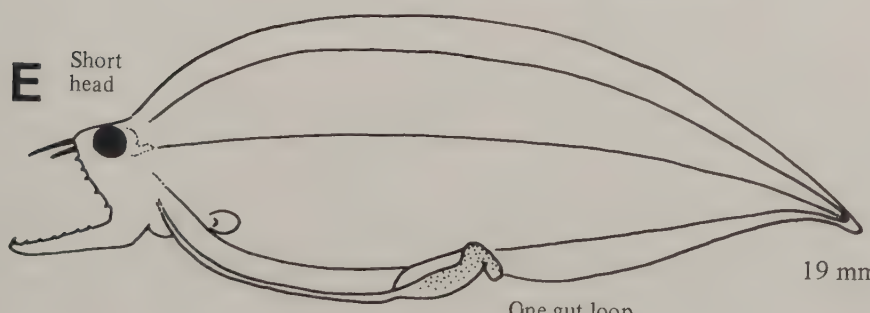
36 mm SL

EURYPHARYNGIDAE

*Eurypharynx pelecanoides*

E

Short head



19 mm SL

One gut loop

Figure A, Smith 1984; B–C, Smith 1979; D, Bauchot 1959; E, Fahay 1983 (after Smith 1979).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 181-193-201 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | X-X-X |
| **Caudal fin** | Reduced |
| **Pelvic fin** | Absent |
| **Dorsal fin** | R: 279-339-432 |
| | D100: 130-164-210[a] |
| **Pectoral fin** | R: 14-16-18 |
| **Anal fin** | R: 240-299-372 |
| | A100: 103-138-176[a] |
| **Gill rakers** | U: X-X-X L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Aleutian Is., 51-55°N |
| **Ecology** | Meso- and bathypelagic, 510-4580 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

**Preanal length**
**Length at flexion**
**Length at transformation**
**Sequence of fin development** Dorsal and anal (late)
**Pigment**

- Small spots on top of spinal cord, at least posteriorly
- Row of spots dorsally along gut length, ventral row anterior to stomach
- Several groups (usually three) of internal spots along body subaxially—about four spots in each group[b]
- Dorsal and anal fin bases

**Diagnostic characters**

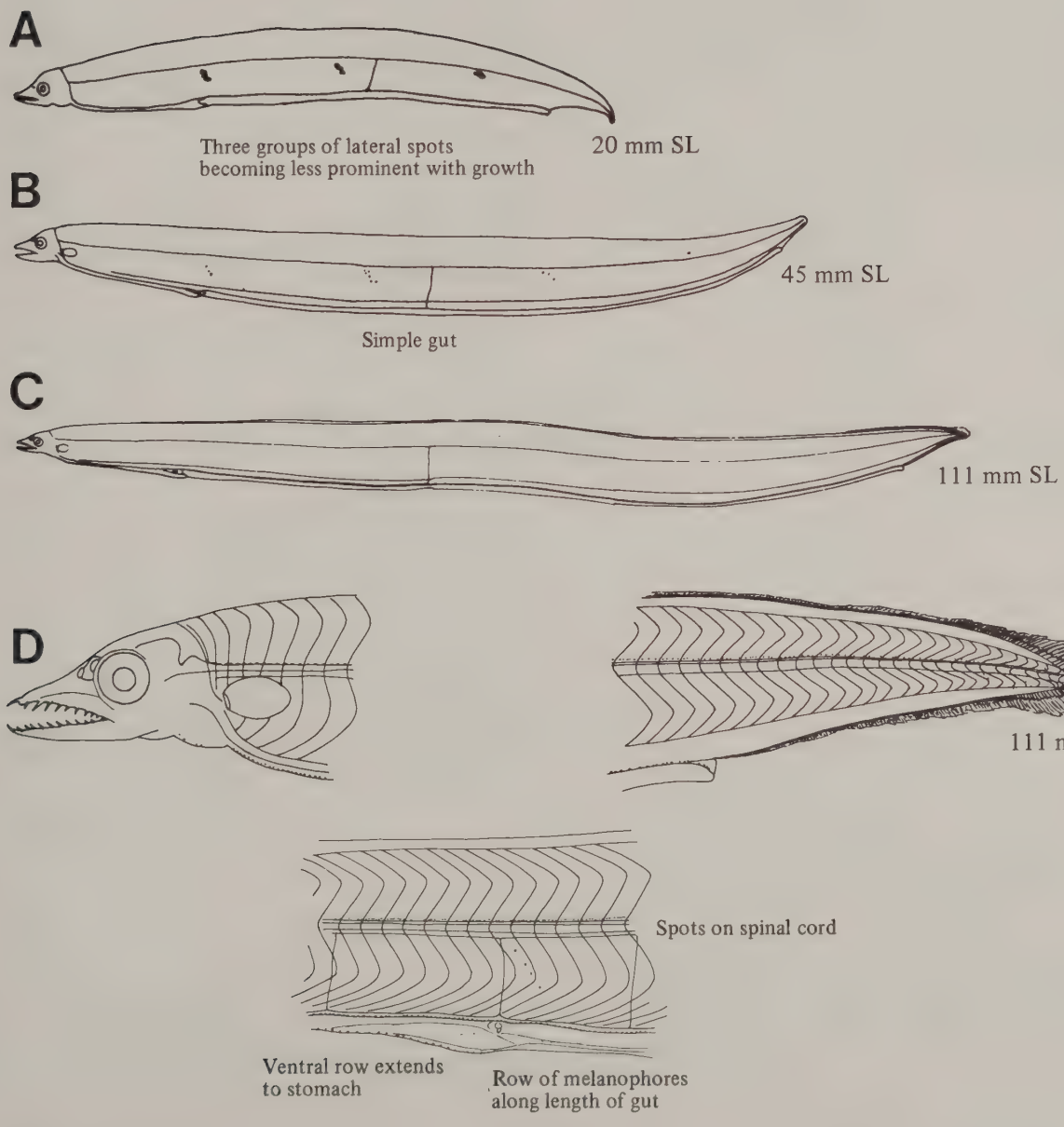
Distinguished from *Nemichthys* spp. by

- Body less elongate
- Caudal structure (tail more round, not filiform)
- Position of liver and last blood vessel, 30th and 70-88th myomere, respectively
- Number of myomeres (181-201)

[a] The total dorsal and anal fin ray counts and the number of lateral line pores and vertebrae are often of no value; they are not comparable because caudal parts are often missing and regeneration may have occurred. Nielsen and Smith (1978) introduced artificial lengths/counts with a greater comparative value which we employ here (see their Materials and Methods section for a complete discussion), e.g., D200, A200 = number of fin rays anterior to vertebrae no. 201.

[b] According to Smith (1979), there are three blotches of internal lateral pigment spots which become less prominent with growth.

Ref: Castle 1984, Nielsen and Smith 1978, Smith 1979.




Figures A–D, Smith 1979.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 300-300-300 |
| | Precaudal: 77-85-105 |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 7-X-15 |
| **Caudal fin** | Reduced |
| **Pelvic fin** | Absent |
| **Dorsal fin** | R: 330-330-330 |
| | D200: 170-207-253[a] |
| **Pectoral fin** | R: 10-11-14 |
| **Anal fin** | R: 320-320-320 |
| | A200:186-218-273[a] |
| **Gill rakers** | U: X-X-X L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Brit. Col., 48°30′-55°N |
| **Ecology** | Epi-, meso-, and bathypelagic, 91-1829 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | |
| **Length at flexion** | |
| **Length at transformation** | ~200 mm SL |
| **Sequence of fin development** | Dorsal and anal (late) |

**Pigment**

- Three prominent spots laterally below midline in small larvae (lower on body than on *Avocettina infans*)
- Above gut along length
- Above spinal cord

**Diagnostic characters**

- Elongate with filiform tail
- Number of myomeres (>300)

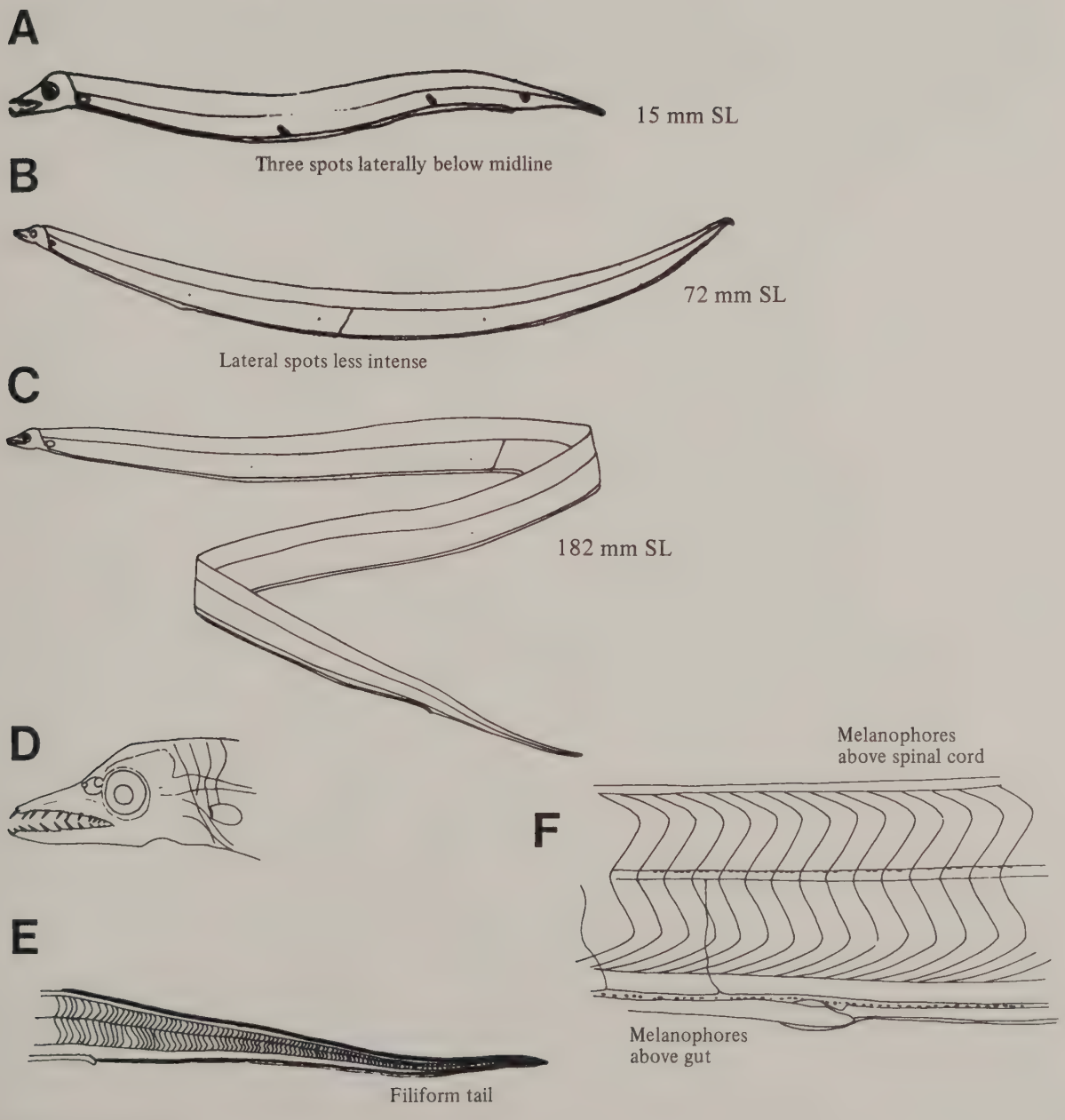
Distinguished from *A. infans* by

- Position of liver (myomere 40) and last vertical blood vessel (80-100th myomere)

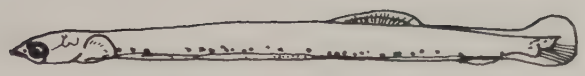
*Nemichthys larseni* larvae are not known but adults occur within the study area. See Table 5 for data on adults. Additional meristic characters from Nielsen and Smith (1978) are: D200, 173-205-222; A200, 164-200-208. See *A. infans* (p. 38, footnote a).

[a] See *Avocettina infans*.

Ref: Castle 1965, 1984; Nielsen and Smith 1978.




Figures A–F, Smith 1979.



## Clupeiformes

The Clupeiformes (herrings, anchovies) are generally small, coastal marine fishes that occur worldwide. Most species form schools and swim near the surface in nearshore waters, feeding on plankton. They have specialized gill rakers for straining large amounts of water. The order consists of 4 families, 78 genera, and about 317 species (McGowan and Berry 1984). Clupeids generally lay demersal eggs whereas engraulidids have pelagic eggs that are sometimes ellipsoidal in shape. Larvae are elongate and similar in appearance but may be distinguished by myomere counts and pigmentation characters.

Families in study area: **Clupeidae**
**Engraulididae**

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 46-52-57[a] | |
| | Precaudal: 29-31-32 | |
| | Caudal: 19-22-22 | |
| **Branchiostegal rays** | 8-X-9 | |
| **Caudal fin** | 9, 10+9, 8-9 | |
| **Pelvic fin** | Abdominal | |
| | R: 9-9-9 | |
| **Dorsal fin** | R: 15-18-21 | |
| **Pectoral fin** | R: 17-17-17 | |
| **Anal fin** | R: 13-16-20 | |
| **Gill rakers** | U: 20-20-20 | L: 45-45-45[a] |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Arctic, not specific |
| **Ecology** | Nearshore shelf pelagic, 0-137 m;[b] 475 m[c] |
| **ELH pattern** | Oviparous; demersal, adhesive attached eggs; pelagic larvae |
| **Spawning** | Season: Jan-Apr (California), Mar-June (Alaska)[d]<br>Area: Demersal (usually on vegetation), nearshore[e]<br>Mode: Schools[e]<br>Migration: Inshore[e] |
| **Fecundity** | Range/function: 6300-41,000/ $F=0.000000436\times L^{4.71}$, L=SL mm[f] |
| **Age at first maturity** | 2-4 yr (Puget Sound)[f]<br>2-6 yr (Bering Sea)[g] |
| **Longevity** | >19 yr[h] |

[a] McGowan and Berry (1984) report total vertebral counts of 53-60 and lower gill raker counts of 37-52.
[b] Alaska Department of Fish and Game 1985
[c] Allen and Smith 1988
[d] Scattergood et al. 1959
[e] Schaefer 1937
[f] Katz 1942
[g] Rudomilov 1972
[h] Fitch and Lavenberg 1975

Ref: Garrison and Miller 1982, Grant 1986, McGowan and Berry 1984.

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.3-1.7 mm |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | Segmented |
| **Envelope** | Smooth, clear, thick |
| **Hatch size** | 5.6-7.5 mm SL (7 mm); yolk absorbed 9-10 mm SL |
| **Incubation time/temp.** | 14-15 d/8.5°C |
| **Pigment** | |

**Diagnostic characters**
- Wide perivitelline space

### LARVAE

| | |
|---|---|
| **Preanal length** | 72% SL |
| **Length at flexion** | 18 mm SL |
| **Length at transformation** | 26-35 mm SL |
| **Sequence of fin development** | Caudal, dorsal, anal, pelvics, pectorals |

**Pigment**
- Isthmus, thoracic region
- Gut: Dorsal, midventral (midventral melanophores on intestine usually paired, sometimes slightly offset)
- Caudal, hypural

**Diagnostic characters** (see Table 4)

Distinguished from *Engraulis mordax* (p. 48) by
- More myomeres (usually >50)
- Longer gut (consistently >70% SL)
- Placement of dorsal fin relative to anus (6-7 myomeres between dorsal and anal fins)
- Less isthmus pigment
- Prominent swimbladder in *E. mordax*
- Dorsal spots at notochord tip usually not in *E. mordax*
- Generally more pigmented

Distinguished from *Sardinops sagax* by
- Presence of posteroventral pigment on gut
- Dorsal spots at notochord tip usually not in *S. sagax*

See also *Mallotus villosus* (p. 80) and *Ammodytes hexapterus* (p. 540)

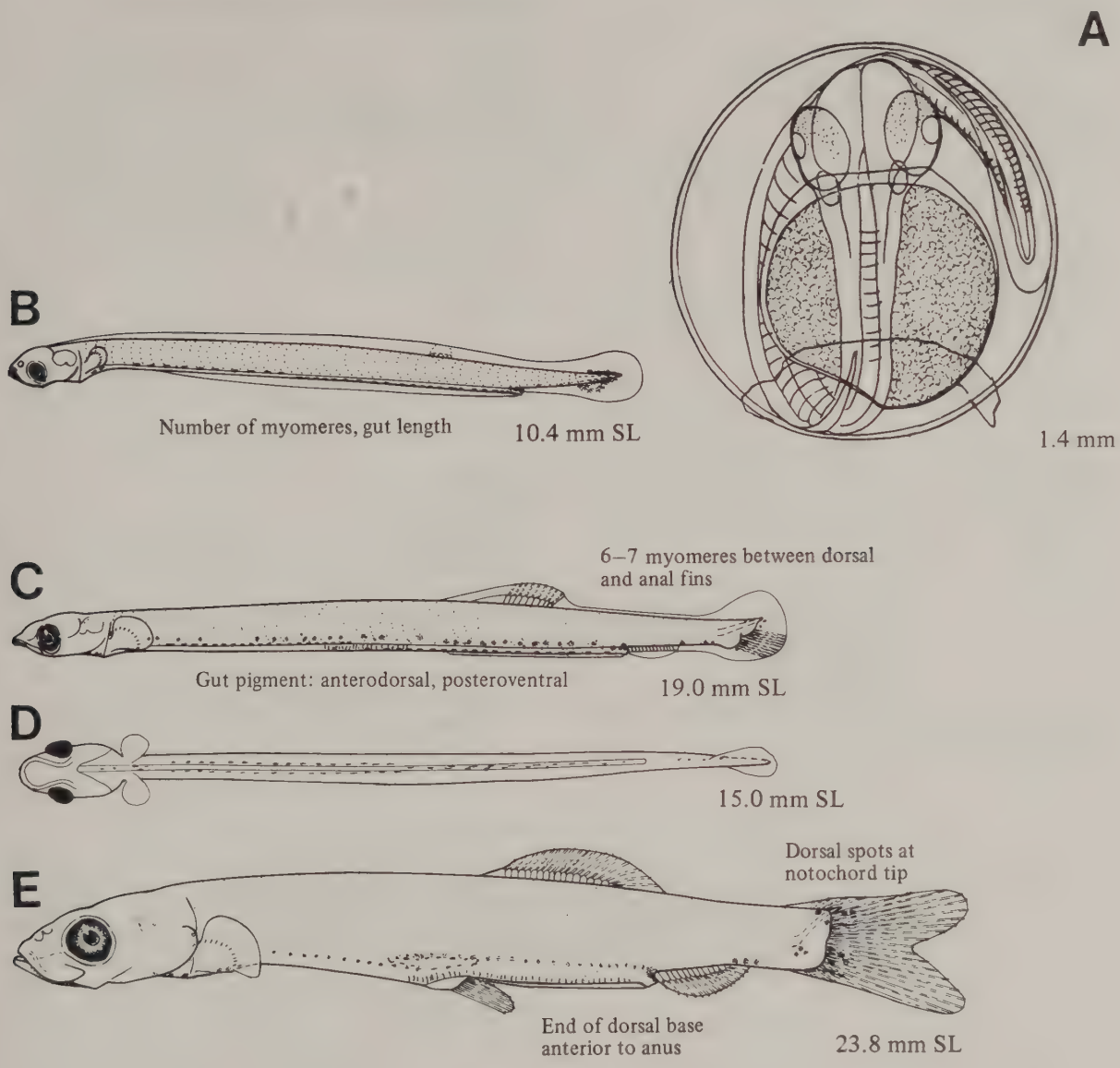



Figure A, Uchida et al. 1958; B–E (D, ventral view), NWAFC originals (B. Vinter).

## MERISTICS[a]

| | | |
|---|---|---|
| **Vertebrae** | Total: 48-X-54 | |
| | Precaudal: 28-29-30 | |
| | Caudal: 22-22-23 | |
| **Branchiostegal rays** | 6-X-10 | |
| **Caudal fin** | 7-9, 10+9, 6-8 | |
| **Pelvic fin** | Abdominal | |
| | R: 8-8-8 | |
| **Dorsal fin** | R: 17-X-20 | |
| **Pectoral fin** | R: 17-17-17 | |
| **Anal fin** | R: 17-X-20 | |
| **Gill rakers** | U: 21-X-23 | L:44-X-45 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to SE Alaska, 55-59°N |
| **Ecology** | Nearshore shelf pelagic, 0-80 m[b] |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Winter-summer[c]<br>Area: Near surface in coastal and offshore waters[b]<br>Mode: Pelagic, schools<br>Migration: |
| **Fecundity** | Range/function: 30,000-65,000[c] |
| **Age at first maturity** | 1-2 yr[b] |
| **Longevity** | 10 yr[b], possibly 25 yr[d] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.34-2.05 mm |
| **No. of oil globules** | One |
| **Oil globule diameter** | 0.16 mm |
| **Yolk** | Irregularly segmented |
| **Envelope** | Smooth, thin |
| **Hatch size** | 3.5-3.75 mm SL |
| **Incubation time/temp.** | 2.5 d/17°C; 2.5-4 d/ 13-16°C[e] |

**Pigment**

**Diagnostic characters**

- Wide perivitelline space

### LARVAE

| | |
|---|---|
| **Preanal length** | >75% SL |
| **Length at flexion** | 9.0-14.0 mm SL |
| **Length at transformation** | 35 mm SL |
| **Sequence of fin development** | Caudal, dorsal, anal, pelvics, pectorals |

**Pigment**

- Row of melanophores along dorsal surface of gut and along ventral midline
- Melanophores over anterior gut appear dash-like, and those over posterior gut become larger and more intense with development

**Diagnostic characters** (see Table 4)

- See *Clupea pallasi* (p. 44)
- Dash-like melanophores along anterior surface of gut

Distinguished from *C. pallasi* by

- Lack of posteroventral pigment on gut

Distinguished from *Engraulis mordax* (p. 48) by

- Dorsal and anal fin placement (6-8 myomeres between fins)

[a] Meristics include information from McGowan and Berry 1984.
[b] Frey 1971
[c] Hart 1973
[d] Fitch and Lavenberg 1971
[e] Garrison and Miller 1982

Ref: McGowan and Berry 1984.

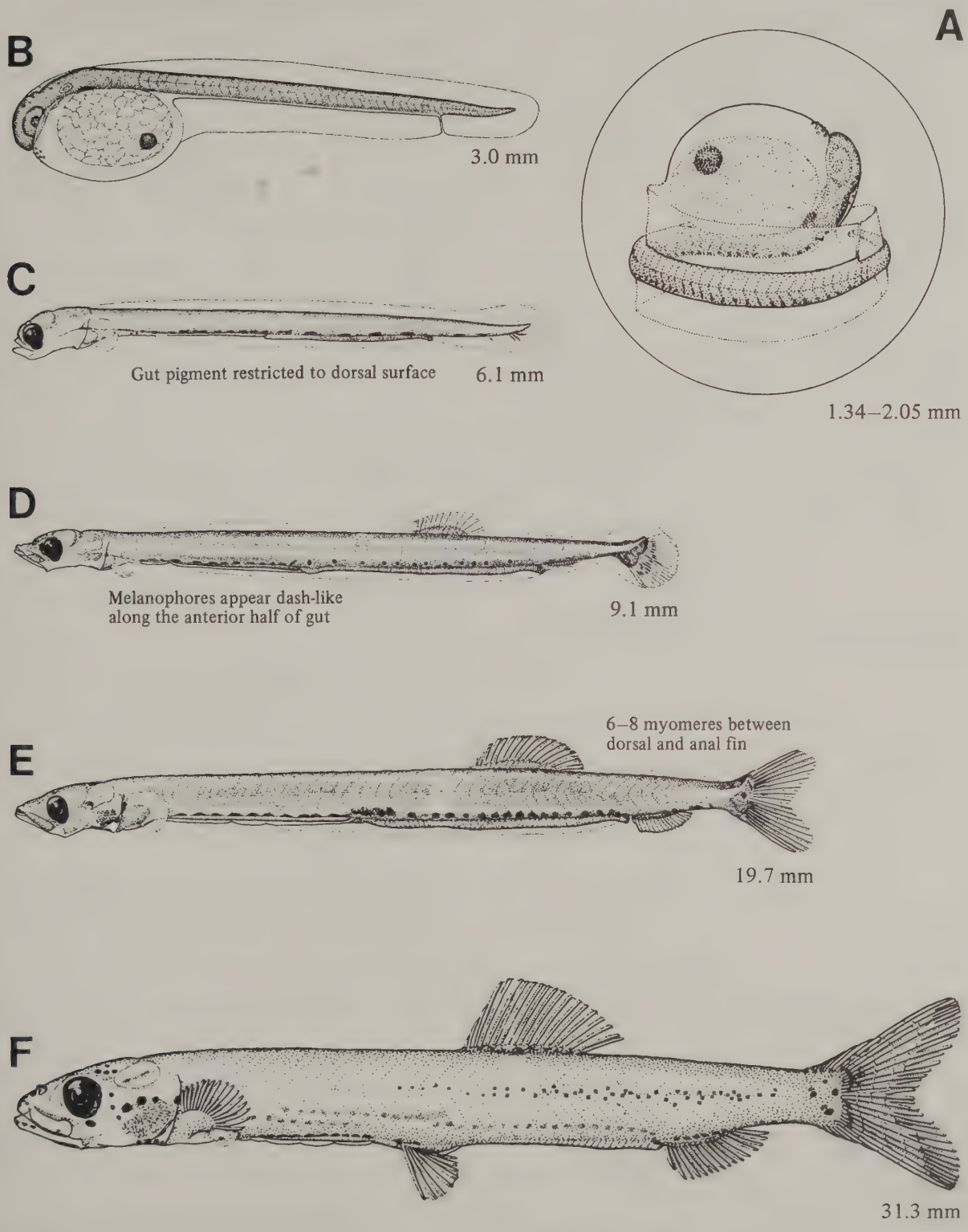



Figure A, Matarese and Sandknop 1984; B–F, Kramer 1970. Stippling in these figures is not pigment.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 43-46-47 | |
| | Precaudal: 24-25-26 | |
| | Caudal: 19-20-21 | |
| **Branchiostegal rays** | 14-14-14 | |
| **Caudal fin** | 8-10, 10+9, 8-10 | |
| **Pelvic fin** | Abdominal | |
| | R: 6-6-6 | |
| **Dorsal fin** | R: 14-X-19 | |
| **Pectoral fin** | R: 13-X-20 | |
| **Anal fin** | R: 19-X-26 | |
| **Gill rakers** | U: 28-X-41 | L: 37-X-45 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Brit. Col., 48°30′-55°N |
| **Ecology** | Epi- and mesopelagic, 0-300 m[a] |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: May[b] to mid-Aug[c]; year-round (California)[d] |
| | Area: Pelagic |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: 4025[e]-30,000[f] |
| **Age at first maturity** | 1-2 yr[g] |
| **Longevity** | 7 yr[h] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.23-1.55 mm × 0.6-0.8 mm |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | Segmented |
| **Envelope** | Smooth, transparent |
| **Hatch size** | 2.5-3.0 mm SL; yolk absorbed 3.5-4.0 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**
- Ovoid
- Narrow perivitelline space

### LARVAE

| | |
|---|---|
| **Preanal length** | 60-66% increasing to 75% SL, decreases in postflexion larvae |
| **Length at flexion** | |
| **Length at transformation** | |
| **Sequence of fin development** | Caudal, dorsal, anal, pelvics, pectorals |

**Pigment**
- Isthmus
- Row of melanophores along dorsal surface of gut continuing along ventral body midline
- Ventral pigment on gut beginning about midway

**Diagnostic characters** (see Table 4)
- See *Clupea pallasi* (p. 44)
- Isthmus pigment present
- Dorsal and anal fin placement (0-2 myomeres between fins)
- Midventral melanophores on intestine usually staggered, not single as in osmerids, and usually not as evenly paired as in *C. pallasi*

[a] Pacific Fisheries Management Council 1978
[b] Kendall and Clark 1982
[c] Blackburn 1973
[d] Lasker and Smith 1977
[e] Frey 1971
[f] Baxter 1967
[g] Clark and Phillips 1952
[h] Hart 1973

Ref: McGowan and Berry 1984, Wang 1981.

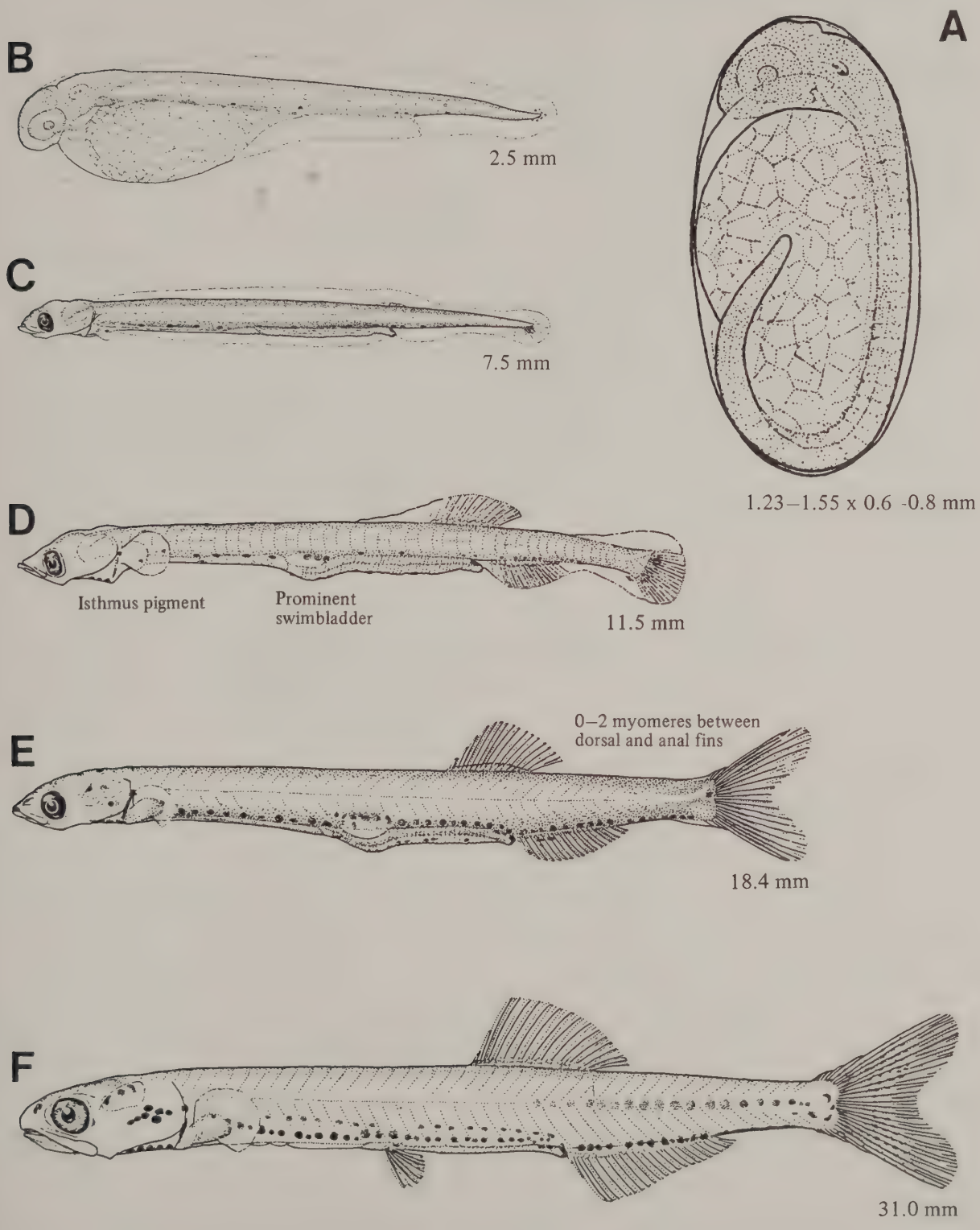
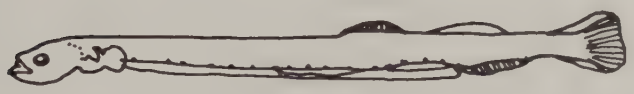



Figure A, Bolin 1936; B–F, Kramer and Ahlstrom 1968. Stippling in these figures is not pigment.



## Salmoniformes

The salmoniform fishes (salmons, smelts, deep sea smelts, and others) are primarily freshwater spawners except for members of the Argentinoidei, the largest taxon of salmoniforms with marine eggs and larvae in our area. There is much disagreement as to the composition of the order (see Fink 1984). In our area, it consists of 4 suborders, 15 families, 90 genera, and about 320 species (J. Nelson 1984). The argentinoids are mostly deep-sea fishes. Eggs are pelagic and have distinctive pustules on the inner surface of the egg membranes; larvae have a variety of forms. Larval characters include presence/absence of eyestalks, unique development of median fins, and distinctive pigment patterns. Pigment patterns for bathylagids are discussed according to the categories described by Ahlstrom et al. (1984b)—species with large, isolated melanophores and those with a linear series of small melanophores.

A summary of meristic characters is included for Alepocephalidae and Platytroctidae. Although salmon parr are occasionally collected in plankton tows, they are not treated here. Information on their early life history is reviewed in Kendall and Behnke (1984).

Families in study area: **Argentinidae**
**Bathylagidae**
**Opisthoproctidae**
**Alepocephalidae**
**Platytroctidae**
**Osmeridae**
**Salmonidae**

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 47-X-51 |
| | Precaudal: 30-31-32 |
| | Caudal: 16-18-18 |
| **Branchiostegal rays** | 5-5-5 |
| **Caudal fin** | 12, 10+9, 11 |
| **Pelvic fin** | Abdominal |
| | R: 10-11-12 |
| **Dorsal fin** | R: 10-X-13 |
| **Pectoral fin** | R: 11-X-18 |
| **Anal fin** | R: 12-X-15 |
| **Gill rakers** | U: 7-8-9 L:14-17-20 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Oregon, 42-46°N |
| **Ecology** | Epi- and mesopelagic, 11-274 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Jan-spring[a] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | >5 yr[a] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.31-1.66 mm |
| **No. of oil globules** | One, at vegetal pole |
| **Oil globule diameter** | 0.27-0.46 mm |
| **Yolk** | Segmented |
| **Envelope** | Pustules (pronounced raised bumps on inner surface) |
| **Hatch size** | |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

- Pustules more pronounced than in bathylagid eggs

### LARVAE

| | |
|---|---|
| **Preanal length** | 76-84% SL |
| **Length at flexion** | >9 mm SL |
| **Length at transformation** | 25-30 mm SL (prolonged)[b] |
| **Sequence of fin development** | Caudal, dorsal and anal, pectorals, pelvics |

**Pigment**

- Internal head pigment
- Series of ventral trunk blotches extending from pectoral fin to end of gut
- 1-2 large blotches postanal with a large caudal blotch
- Blotches expand with development (see figure)

**Diagnostic characters**

- Transverse rugae lining gut
- Fin rays form in finfold, away from body margin

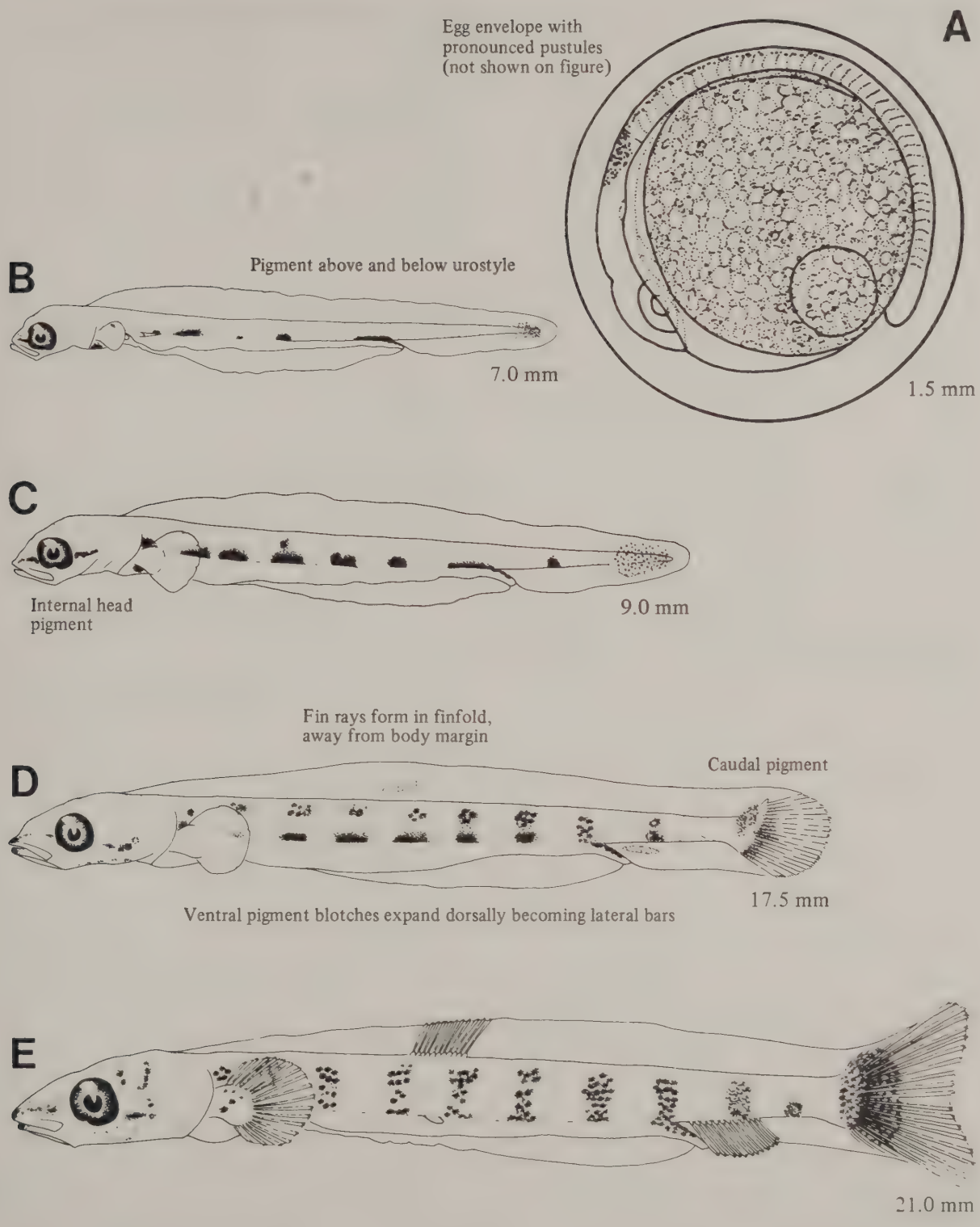
Distinguished from *Nansenia candida* by

- Presence of internal head pigment
- Caudal pigment on preflexion larvae
- Fewer spots over gut

[a] Fitch and Lavenberg 1968

[b] Transformation: Morphological changes (deepening of body, lengthening of snout, enlargement of eye) and folding of anterior gut to form stomach, along with masking of larval pigment, occur at 25-30 mm. Pelagic juveniles may occur at 50-100 mm.

Ref: Ahlstrom et al. 1984b.




Figures A–E, Ahlstrom et al. 1984b.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 44-X-47 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 3-3-3 | |
| **Caudal fin** | 11, 10+9, 14 | |
| **Pelvic fin** | Abdominal | |
| | R: 9-10-10 | |
| **Dorsal fin** | R: 9-X-10[b] | |
| **Pectoral fin** | R: 9-X-11[b] | |
| **Anal fin** | R: 8-X-9 | |
| **Gill rakers** | U: 12-12-12 | L: 18-18-18 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Gulf of Alaska, 54-60°N |
| **Ecology** | Epi- and mesopelagic, 200-1000 m[c] |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.39-1.56 mm |
| **No. of oil globules** | One, at vegetal pole |
| **Oil globule diameter** | 0.41-0.49 mm |
| **Yolk** | |
| **Envelope** | Pustules |
| **Hatch size** | |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

- Pustules

### LARVAE

| | |
|---|---|
| **Preanal length** | 74-82% SL |
| **Length at flexion** | |
| **Length at transformation** | ~15 mm SL |
| **Sequence of fin development** | Caudal, dorsal, anal, pectorals, pelvics |

**Pigment**

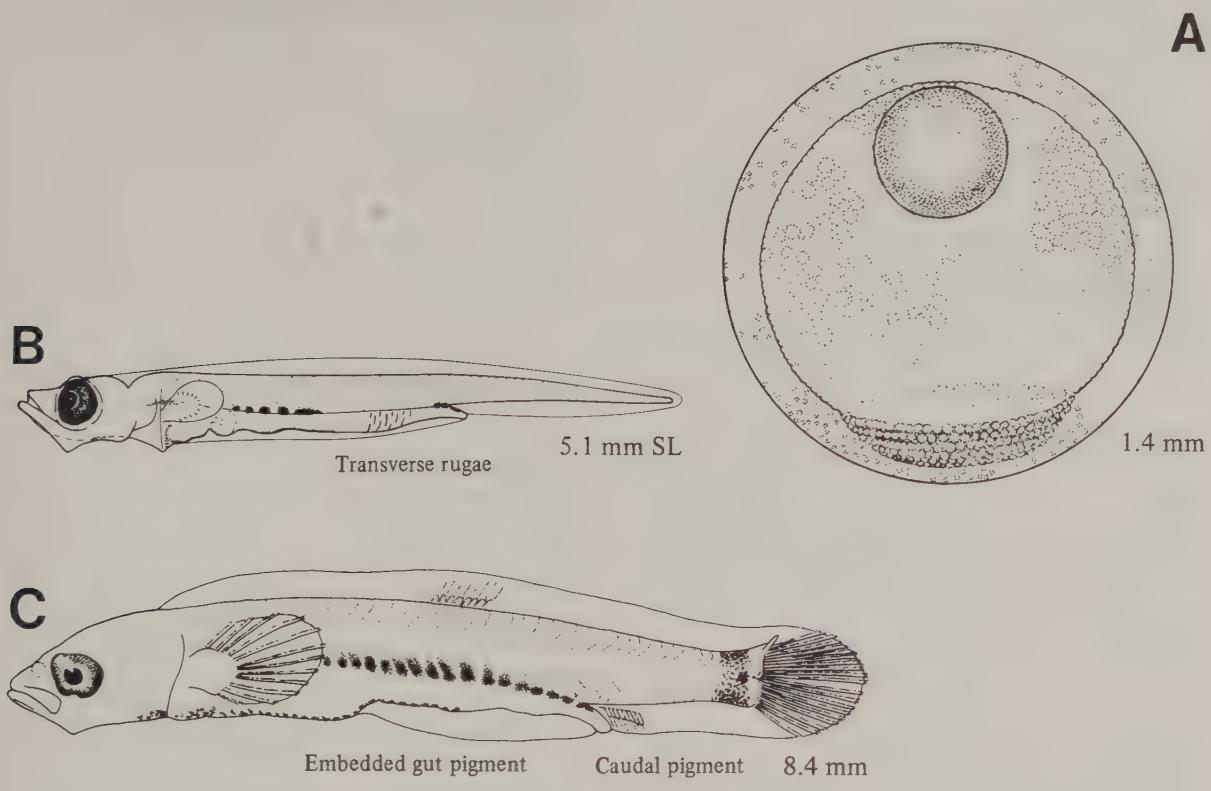
- Embedded pigment above gut
- Superficial head pigment (>8.4 mm SL)
- With development, embedded line of melanophores running length of body
- Conspicuous caudal pigment
- Ventral pigment from isthmus along anterior 2/3 of gut

**Diagnostic characters**

- Transverse rugae lining gut only in posterior section, anteriorly an elongate s-shaped fold is present along with longitudinal rugae
- Fin rays form in finfold, away from body margin

[a] Referred to by Ahlstrom as northern *Nansenia* (E.H. Ahlstrom notes).
[b] Ahlstrom et al. 1984b
[c] Cohen 1958

Ref: Ahlstrom et al. 1984b.




Figures A, C, Ahlstrom et al. 1984b; B, NWAFC original (B. Vinter).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 48-X-53 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 2-2-2 |
| **Caudal fin** | X, 10+9, X |
| **Pelvic fin** | Abdominal |
| | R: 9-X-10[a] |
| **Dorsal fin** | R: 10-10-11 |
| **Pectoral fin** | R: 10-10-12 |
| **Anal fin** | R: 18-X-22[a] |
| **Gill rakers** | U: X-X-X L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Cent. California, 34-38°N, to Oregon, 42-46°N |
| **Ecology** | Mesopelagic, 200-1000 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 84-89% SL |
| **Length at flexion** | |
| **Length at transformation[b]** | |
| **Sequence of fin development** | Caudal, dorsal, anal, pectorals, pelvics |

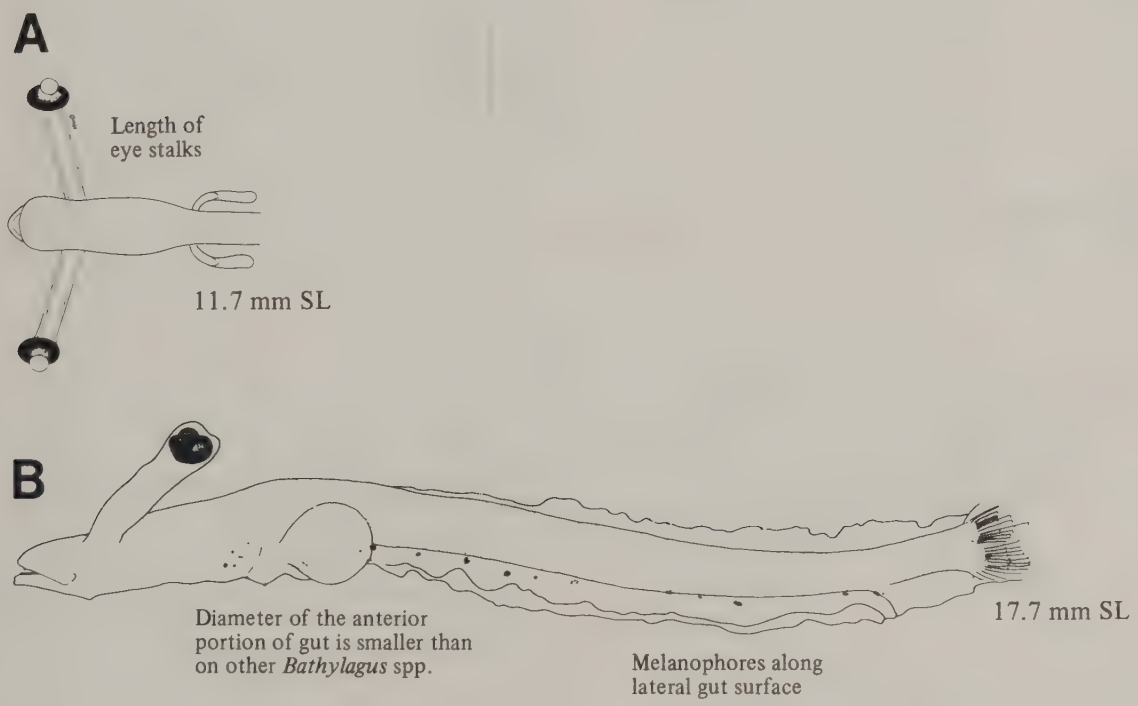
**Pigment** - Linear series of small melanophores
- Series of melanophores (up to 18) along lateral gut
- With development to late postflexion, additional pigment appears on lower jaw, isthmus, opercle, pectoral fin base, and lateral caudal peduncle

**Diagnostic characters**
- Anterior section of gut smaller in diameter compared with other species (see illustration)
- Eye stalks longer and persist into later larval stages (65% HL)
- Fin rays form in finfold, away from body margin

Distinguished from other bathylagids with eyestalks by
- Linear series of small melanophores
- *B. pacificus* has large, isolated spots, long eyestalks, and less intense pigment
- *B. ochotensis* has shorter stalks and more intense pigment

[a] Ahlstrom et al. 1984b
[b] Transformation: Direct, marked in all species; slender body becoming deeper with development, large head and eyes, gut coils and becomes covered by black peritoneal sheath.

Ref: Ahlstrom et al. 1984b.




Figures A–B, Ahlstrom et al. 1984b (North Atlantic specimen).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 50-X-55 |
| | Precaudal: 18-X-21 |
| | Caudal: 30-X-34 |
| **Branchiostegal rays** | 2-2-2 |
| **Caudal fin** | 16-18, 10+9, 15-17 |
| **Pelvic fin** | Abdominal |
| | R: 6-X-8 |
| **Dorsal fin** | R: 6-X-9 |
| **Pectoral fin** | R: 11-X-16 |
| **Anal fin** | R: 20-X-28 |
| **Gill rakers** | U: X-X-X L: 25-X-27[a] |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Bering Sea, 54-66°N |
| **Ecology** | Epi- and mesopelagic, 60-1000 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | Segmented |
| **Envelope** | Pustules on inner surface |
| **Hatch size** | |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 59-61% SL |
| **Length at flexion** | |
| **Length at transformation** | Larval characters visible to 50 mm SL |
| **Sequence of fin development** | Caudal, dorsal, anal, pectorals, pelvics |

**Pigment** - Large isolated melanophores

- Preflexion larvae: Pigment on lower jaw, midgut, and tail
- Flexion larvae
  —Opposing dorsal and ventral midline melanophores
  —Large melanophores on head and pectoral fin base
  —Large lateral blotch at base of caudal fin

**Diagnostic characters**

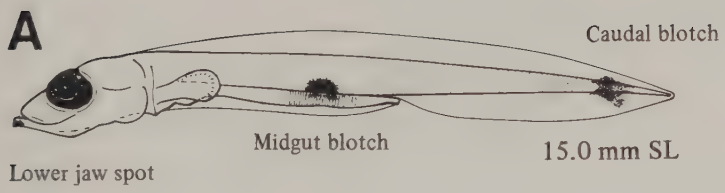
- Gut shorter (usually only 50% SL) than in other species
- Eye rounder and larger than in other bathylagids (not stalked)
- Fin rays develop in finfold, away from body margin

Distinguished from other bathylagids without eyestalks by

- Large isolated spots
- *B. wesethi* has a series of melanophores along hypaxial region, large eye, and spots posteriorly along dorsal midline
- *Leuroglossus* spp. larvae have smaller eyes and no dorsal spots

[a] E.H. Ahlstrom notes

Ref: Ahlstrom et al. 1984b.



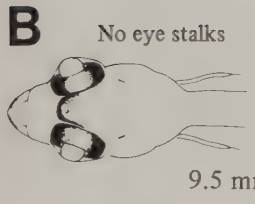



Figure A, NWAFC original (B. Vinter); B–C, Ahlstrom et al. 1984b.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 47-X-49 | |
| | Precaudal: 25-26-27 | |
| | Caudal: 21-22-23 | |
| **Branchiostegal rays** | 2-2-2 | |
| **Caudal fin** | 13-14, 10+9, 15-16 | |
| **Pelvic fin** | Abdominal | |
| | R: 9-10-10 | |
| **Dorsal fin** | R: 9-11-12 | |
| **Pectoral fin** | R: 9-10-11 | |
| **Anal fin** | R: 12-X-15 | |
| **Gill rakers** | U: X-X-X | L: 28-28-28[a] |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Bering Sea, 54-66°N |
| **Ecology** | Epi- and mesopelagic, 49-900 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Jan-Feb[b] |
| | Area: Off continental slope[c] |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 0.92-1.1 mm |
| **No. of oil globules** | >10, usually coalesce to 1 in late stage[d] |
| **Oil globule diameter** | |
| **Yolk** | Segmented |
| **Envelope** | Pustules on inner surface |
| **Hatch size** | |
| **Incubation time/temp.** | |
| **Pigment** | |

- Unpigmented

**Diagnostic characters**

- Lack of pigmentation in late-stage eggs

### LARVAE

| | |
|---|---|
| **Preanal length** | 81-90% SL |
| **Length at flexion** | |
| **Length at transformation** | |
| **Sequence of fin development** | Caudal, dorsal, anal, pectorals, pelvics |

**Pigment** - Linear series of small melanophores

- Series of melanophores develops on hypaxial myomeres
- Epaxial melanophores limited to posterior body
- Series along posterior gut
- May occur on urostyle at sizes <7.9 mm SL

**Diagnostic characters**

- Eye stalks

Distinguished from other bathylagids with linear series of smaller melanophores by

- Posterior gut melanophores larger and fewer
- Anterior region of gut lacks pigment
- Epaxial myomere series limited to posterior region
- Fin rays form in finfold, away from body margin

Distinguished from *B. bericoides* by

- Small *B. bericoides* larvae are unavailable but presumably eye stalks are longer at comparable stages

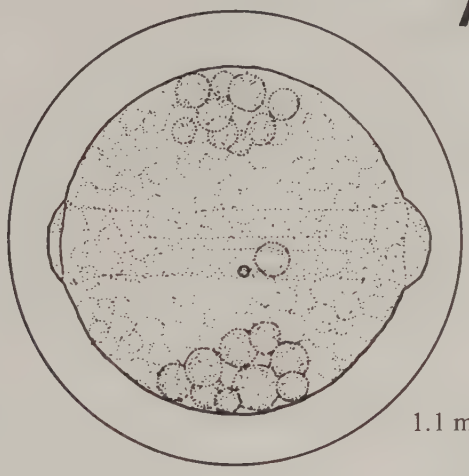
Distinguished from *B. pacificus* by

- Series of melanophores as opposed to isolated spots

[a] E.H. Ahlstrom notes
[b] Wang 1981
[c] Ahlstrom 1965
[d] Numerous globules at vegetal pole which coalesce to one clump at each equatorial pole.

Ref: Ahlstrom et al. 1984b.

A

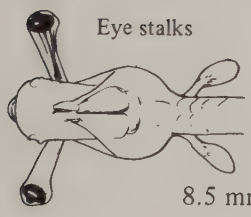


1.1 mm

B

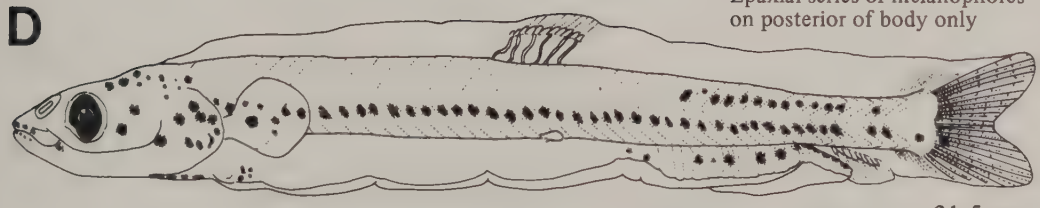
Series of spots along hypaxial myomeres 7.9 mm SL

C




8.5 mm SL

D




21.5 mm

Anterior gut larger than posterior gut, lacks pigment

Posterior gut subdivided, and with pigment

Figures A, C–D, Ahlstrom et al. 1984b; B, NWAFC original (B. Vinter).

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 44-X-49 | |
| | Precaudal: 18-X-25 | |
| | Caudal: 21-X-28 | |
| **Branchiostegal rays** | 2-2-2 | |
| **Caudal fin** | 13, 10+9, 13-14 | |
| **Pelvic fin** | Abdominal | |
| | R: 7-X-10 | |
| **Dorsal fin** | R: 8-X-9 | |
| **Pectoral fin** | R: 7-X-11 | |
| **Anal fin** | R: 15-X-22 | |
| **Gill rakers** | U: X-X-X | L: 28-X-32[a] |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Bering Sea, 54-66°N |
| **Ecology** | Epi- and mesopelagic, 149-1000 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Feb-Mar;[b] spring[c] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | Segmented |
| **Envelope** | Pustules |
| **Hatch size** | |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 76-85% SL |
| **Length at flexion** | |
| **Length at transformation** | |
| **Sequence of fin development** | Caudal, dorsal, anal, pectorals, pelvics |

**Pigment** - Large isolated melanophores

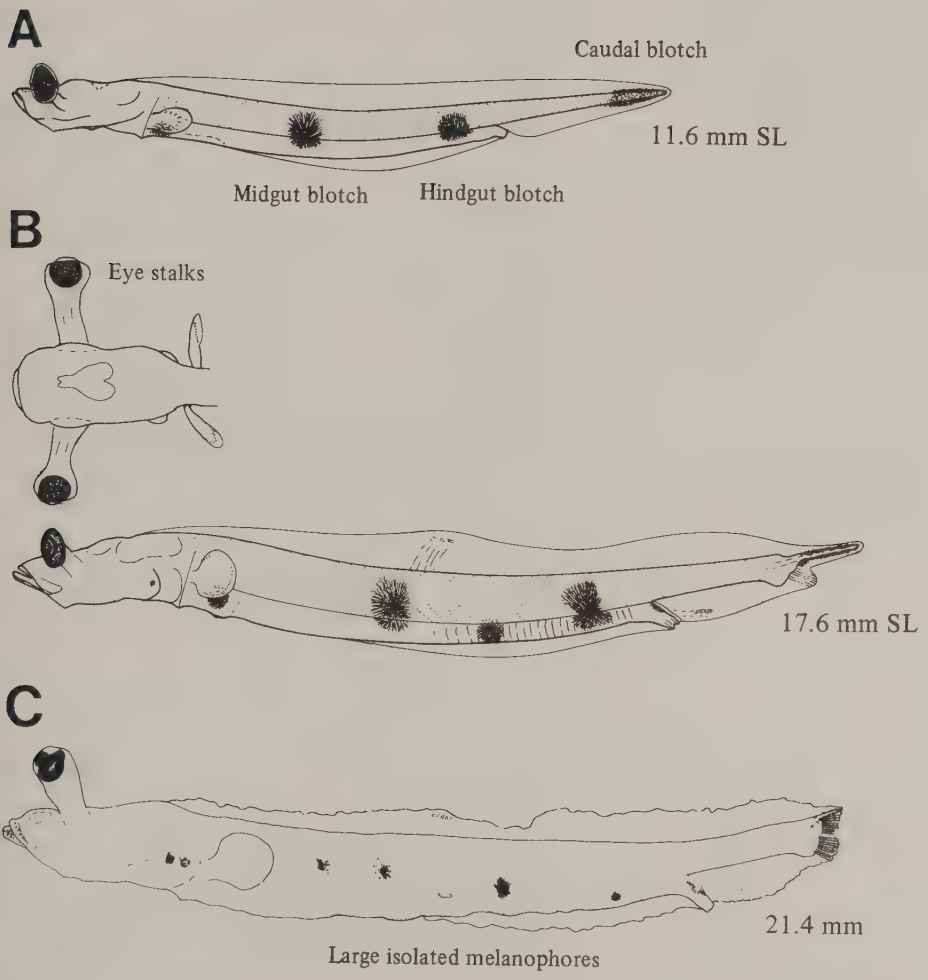
- Early larvae have large lateral blotch at midbody and another posteriad, becoming located on trunk with development
- Third blotch forms midway between and below other two blotches
- Fourth lateral trunk blotch forms in some late larval specimens between pectoral fin and large midbody blotch
- Other melanophores form lateral to liver and terminal section of gut
- Also isthmus/thoracic, dorsal gut, caudal, and two bands on body (early)

**Diagnostic characters**

- Stalked eyes
- Fin rays form in finfold, away from body margin
- Only bathylagid with stalked eyes and pigment consisting of large isolated spots

[a] E.H. Ahlstrom notes
[b] Wang 1981
[c] Fitch and Lavenberg 1968

Ref: Ahlstrom et al. 1984b.




Figures A–B, NWAFC original (B. Vinter); C, Ahlstrom et al. 1984b.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 43-X-46 |
| | Precaudal: 23-23-23 |
| | Caudal: 22-22-22 |
| **Branchiostegal rays** | 2-2-2 |
| **Caudal fin** | 14-15, 10+9, 14-15 |
| **Pelvic fin** | Abdominal |
| | R: 9-X-11 |
| **Dorsal fin** | R: 11-12-13 |
| **Pectoral fin** | R: 9-10-11 |
| **Anal fin** | R: 14-X-16 |
| **Gill rakers** | U: 8-8-8 L: 16-X-17 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Oregon, 42-46°N |
| **Ecology** | Epi- and mesopelagic, 40-1000 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 0.90-1.10 mm |
| **No. of oil globules** | 12-20, subequal[a] |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | |
| **Incubation time/temp.** | |
| **Pigment** | |

- No pigment over oil globules

**Diagnostic characters**

### LARVAE[b]

| | |
|---|---|
| **Preanal length** | 79-94% SL |
| **Length at flexion** | >6 mm, by 11 mm SL |
| **Length at transformation** | ~25 mm SL |
| **Sequence of fin development** | Caudal, dorsal, anal, pectorals, pelvics |

**Pigment** - Linear series of small melanophores

- Initially a series of paired spots dorsolaterally to gut extending from pectoral fin base to terminal section, becoming embedded with development (6-8 pairs developing to 7-8 pairs)
- Notochord tip (dorsal and ventral)

At flexion

- Series of melanophores develops along hypaxial region, and soon after a series develops along epaxial
- More lateral spots are added
- Median finfold
- Increased head pigment

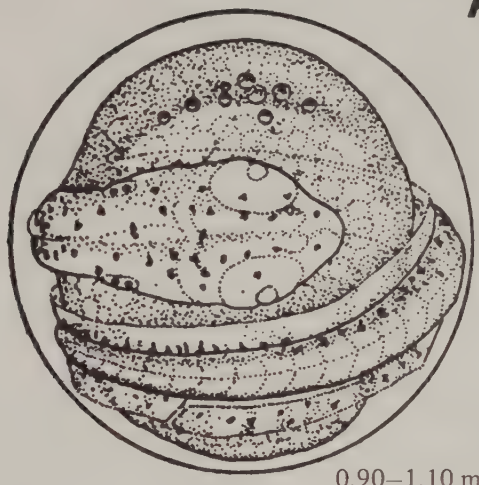
**Diagnostic characters**

- Eyes not stalked
- Pigment pattern unique among *Bathylagus* spp. (including *Leuroglossus* spp.)
- Fin rays form in finfold, away from body margin
- Only bathylagid without stalked eyes and pigment consisting of a linear series of small melanophores

[a] Oil globules may only partially coalesce.
[b] Data on preflexion and postflexion larvae are from E.H. Ahlstrom notes. Illustrations are unavailable.

Ref: Ahlstrom 1965, 1969; Ahlstrom et al. 1984b.

A



0.90–1.10 mm

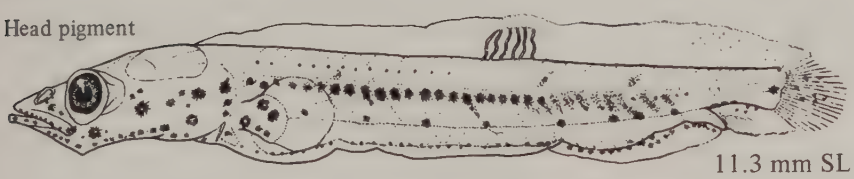
B No eye stalks

8.5 mm SL

C

Median finfold pigment

Head pigment



11.3 mm SL

7–8 pairs dorsolateral gut melanophores

Transverse rugae along entire gut

Figure A, Ahlstrom 1969; B–C, Ahlstrom et al. 1984b.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 47-X-52 |
| | Precaudal: 26-X-29 |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 2-2-2 |
| **Caudal fin** | 15-17, 10+9, 15[b] |
| **Pelvic fin** | Abdominal |
| | R: 8-X-9 |
| **Dorsal fin** | R: 10-X-11 |
| **Pectoral fin** | R: 8-X-9 |
| **Anal fin** | R: 11-X-14 |
| **Gill rakers** | U: 8-X-9 L: 17-X-19 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Brit. Col., 48°30′-55°N, to Bering Sea, 54-66°N |
| **Ecology** | Epi-, meso-, and bathypelagic, 0-1800 m[c] |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Fall-winter;[b] summer[d] |
| | Area: Off continental slope[b] |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.65-1.90 mm |
| **No. of oil globules** | <5 up to 9, usually coalescing to 1[e] |
| **Oil globule diameter** | 0.35-0.40 mm, 0.47 after fusion[e] |
| **Yolk** | Segmented |
| **Envelope** | Pustules |
| **Hatch size** | |
| **Incubation time/temp.** | |
| **Pigment** | |

- Tip of notochord

**Diagnostic characters**

- Egg diameter

### LARVAE

| | |
|---|---|
| **Preanal length** | 72-78% SL |
| **Length at flexion** | 13-18 mm SL |
| **Length at transformation** | 31-35 mm SL |
| **Sequence of fin development** | Caudal, dorsal and anal, pectorals, pelvics |

**Pigment** - Large isolated melanophores

- Series of 5-6 spots on posterior gut
- Midtrunk patch
- Lower trunk blotches
- 1-2 postanal lateral blotches in larger larvae

**Diagnostic characters**

- Eye stalks short and only in early larvae
- Fin rays form in finfold, away from body margin
- More pigmented than *L. stilbius*

Distinguished from *Bathylagus milleri* by

- Eye stalks short
- Lack of dorsal spots

[a] Placed in *Bathylagus* by Ahlstrom et al. 1984b.
[b] Dunn 1983
[c] Fedorov 1973
[d] Ahlstrom 1969
[e] Similar migrations, see *L. stilbius*.

Ref: Ahlstrom 1969, Ahlstrom et al. 1984b, Dunn 1983.

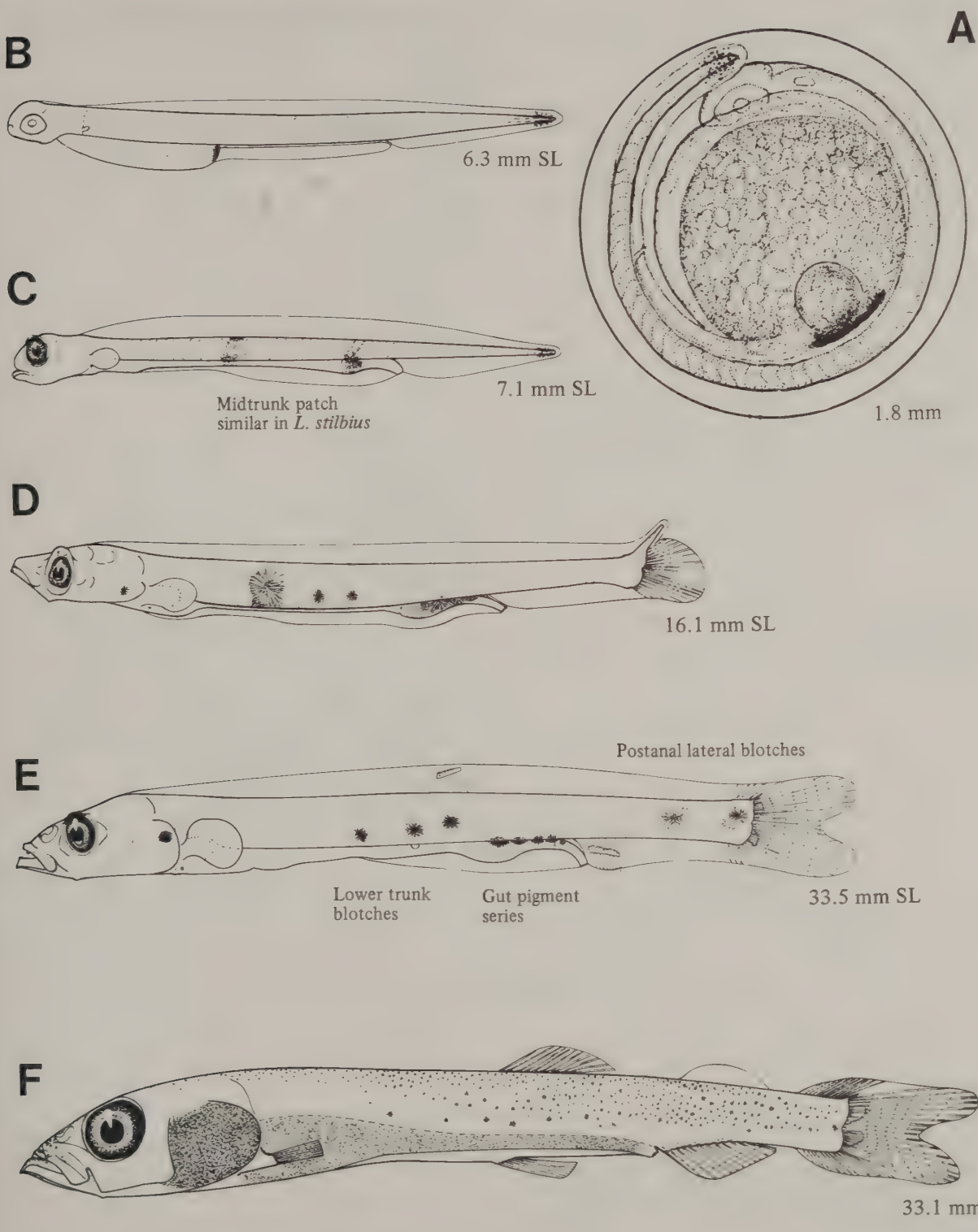



Figure A, Ahlstrom 1969; B–F, Dunn 1983.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 38-X-42 |
| | Precaudal: 20-21-22 |
| | Caudal: 19-20-21 |
| **Branchiostegal rays** | 2-2-2 |
| **Caudal fin** | 12-16, 10+9, 13-15 |
| **Pelvic fin** | Abdominal |
| | R: 8-X-10[b] |
| **Dorsal fin** | R: 9-X-11 |
| **Pectoral fin** | R: 8-X-11 |
| **Anal fin** | R: 11-X-14 |
| **Gill rakers** | U: 7-X-9 L: 18-X-20 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Oregon, 42-46°N |
| **Ecology** | Epi- and mesopelagic, 0-690 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Winter-spring[c] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.10-1.21 mm |
| **No. of oil globules**[d] | |
| **Oil globule diameter** | |
| **Yolk** | Finely segmented |
| **Envelope** | Pustules |
| **Hatch size** | 3 mm SL |
| **Incubation time/temp.** | |

**Pigment**
- Yolk membrane above oil globule
- Notochord tip

**Diagnostic characters**
- Egg diameter: Smaller than in *L. schmidti*

### LARVAE[e]

| | |
|---|---|
| **Preanal length** | 74-80% SL |
| **Length at flexion** | |
| **Length at transformation** | 25-29 mm SL |
| **Sequence of fin development** | Caudal, dorsal and anal, pectorals, pelvics |

**Pigment** - Large isolated melanophores
- Midtrunk patch between pectoral fin base and anus in smaller larvae is similar to *L. schmidti*
- Series of 5-6 melanophores on posterior gut

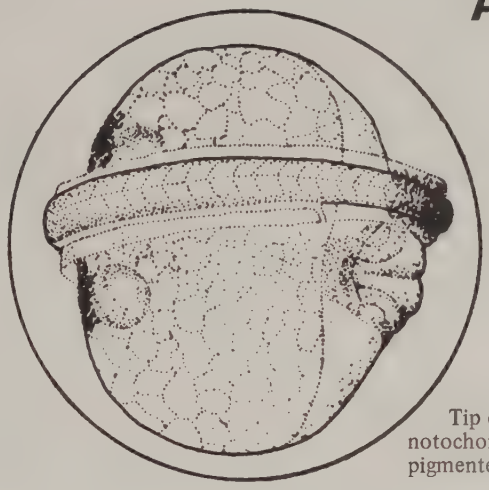
**Diagnostic characters**
- Eye stalks short and only in early larvae
- Fin rays form in finfold, away from body margin

Distinguished from *L. schmidti* by
- Lack of lower trunk and postanal blotches

[a] Placed in *Bathylagus* by Ahlstrom et al. 1984b.
[b] Ahlstrom et al. 1984b
[c] Ahlstrom 1965
[d] After fertilization, 15-25 oil globules at vegetal pole; 2-5 oil globules during early stage which coalesce to 2 (sometimes 1) of equal size at opposite poles. These oil globules migrate toward and coalesce under the embryo prior to hatching.
[e] Data on preflexion and postflexion larvae are from E.H. Ahlstrom notes. Illustrations are unavailable.

Ref: Ahlstrom 1965, 1969; Ahlstrom et al. 1984b.

A




1.10–1.21 mm

B Eye stalks short

8.5 mm SL

C

23.2 mm

5–6 melanophores
on posterior gut

Figure A, Ahlstrom 1969; B–C, Ahlstrom et al. 1984b.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 81-X-84[a] | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 2-2-2 | |
| **Caudal fin** | X, 10+9, X | |
| **Pelvic fin** | Abdominal | |
| | R: 7-7-8[b] | |
| **Dorsal fin** | R: 13-14-16[b] | |
| **Pectoral fin** | R: 10-12-13[b] | |
| **Anal fin** | R: 10-12-14[b] | |
| **Gill rakers** | U: 16-X-20 | L: 28-X-32 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | N. California, 38-42°N, to Brit. Col., 48°30′-55°N |
| **Ecology** | Epi- and mesopelagic |
| **ELH pattern** | Oviparous, eggs probably pelagic, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | (Both sexes appear to mature at 400 mm SL)[b] |
| **Longevity** | 5 yr[c] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 2.2-2.6 (ripe ovarian eggs) |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 80-82% SL |
| **Length at flexion** | |
| **Length at transformation** | Up to 124 mm SL[d] |
| **Sequence of fin development** | Caudal, pectorals and pelvics, dorsal and anal |

**Pigment**

- Dorsal blotches (six pairs), which extend into finfold, and ventral (eight pairs) lateral blotches; blotches alternate except for postanal ones which form a band
- Large caudal blotch
- Head heavily pigmented
- Lower gill arches heavily pigmented
- Pectoral and pelvic fin bases

**Diagnostic characters**

- Gut elongate
- Sac-like stomach (elongate and pointed at tip)

Distinguished from other opisthoproctids by

- Elongate snout with unique triangular flap at tip
- Round eyes (anterodorsal)
- Distinctive heavy pigment pattern
- Number of myomeres (81-84)

[a] Ahlstrom et al. 1984b
[b] Stein and Bond 1985
[c] Fitch and Lavenberg 1968
[d] Transformation (family): Marked by deepening of body and attainment of melanistic integument and large scales.

Ref: Ahlstrom et al. 1984b, Stein and Bond 1985.

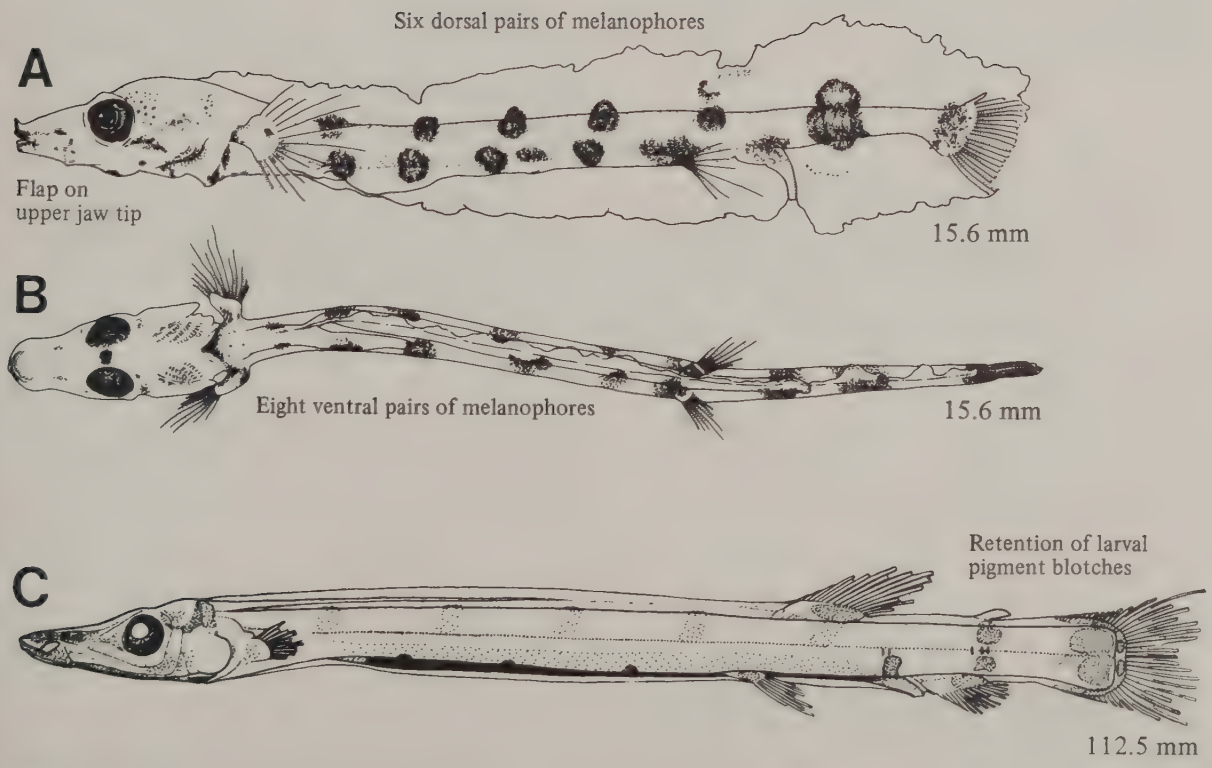



Figure A–B (B, ventral view), Ahlstrom et al. 1984b; C, Cohen 1960.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 40-X-44 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 2-2-2 | |
| **Caudal fin** | X, 10+9, X | |
| **Pelvic fin** | Abdominal | |
| | R: 8-X-9 | |
| **Dorsal fin** | R: 10-X-11 | |
| **Pectoral fin** | R: 13-13-13 | |
| **Anal fin** | R: 8-X-9 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Oregon, 42-46°N |
| **Ecology** | Epi- and mesopelagic, 152-457 m |
| **ELH pattern** | Oviparous, eggs probably pelagic, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | 5 yr[b] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 74-75% SL |
| **Length at flexion** | |
| **Length at transformation** | See *Bathylychnops exilis* |
| **Sequence of fin development** | Pectorals and pelvics probably right after caudal, before dorsal and anal |

**Pigment** - Genus

- Lateral series of melanophores above gut; some species develop serial melanophores on hypaxial myomeres
- Head pigment: Jaws, internal snout, gill arches

**Diagnostic characters**

- Gut elongate (sac-like stomach, elongate and pointed at tip)
- Tubular eyes
- Elongate pectoral and pelvic fin rays
- Number of myomeres (40-44), less than *B. exilis* (81-84) and more than *Macropinna microstoma* (34-37)

[a] According to A.E. Peden (Brit. Col. Prov. Mus., Victoria, B.C., Canada V8V 1X4, pers. commun., 22 Jan. 1987), several species may be in the area with *D. longipes* having the more southerly distribution. Other species may occur north of Oregon and at least one form occurs off British Columbia.
[b] Fitch and Lavenberg 1968

Ref: Ahlstrom et al. 1984b.

A *Dolichopteryx binocularis*

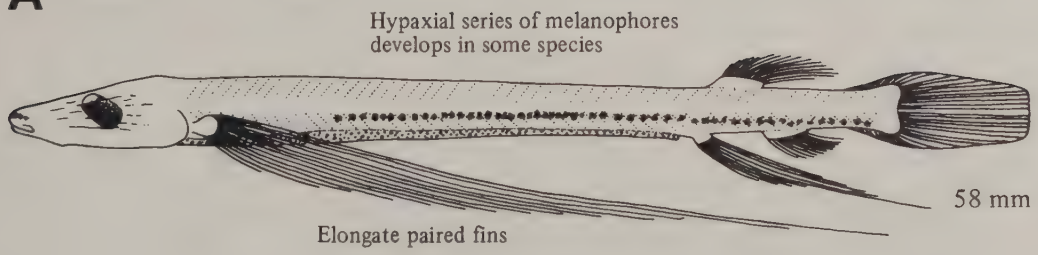



Figure A, Ahlstrom et al. 1984b (after Roule and Angel 1930, Mediterranean specimen).

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 34-X-37 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 3-3-3 | |
| **Caudal fin** | X, 10+9, X | |
| **Pelvic fin** | Abdominal | |
| | R: 9-X-10 | |
| **Dorsal fin** | R: 11-X-12 | |
| **Pectoral fin** | R: 17-X-19 | |
| **Anal fin** | R: 14-14-14 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Bering Sea, 54-66°N |
| **Ecology** | Epi- and mesopelagic, 99-891 m |
| **ELH pattern** | Oviparous, eggs probably pelagic, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 59-64% SL |
| **Length at flexion** | |
| **Length at transformation** | See *Bathylychnops exilis* |
| **Sequence of fin development** | Caudal, pectorals and pelvics, dorsal and anal |

**Pigment**

- Series of melanophores on each hypaxial myomere
- Heavy embedded blotch at pelvic fin base; expands dorsad and ventrad
- Caudal blotch
- Above terminal section on gut ventral to liver
- Lower jaw

**Diagnostic characters**

- Deeper body and shorter gut than *B. exilis* and *Dolichopteryx longipes*
- Head with pronounced hump or bend at nape
- Tubular eyes directed dorsally
- Number of myomeres (34-37)

Ref: Ahlstrom et al. 1984b.

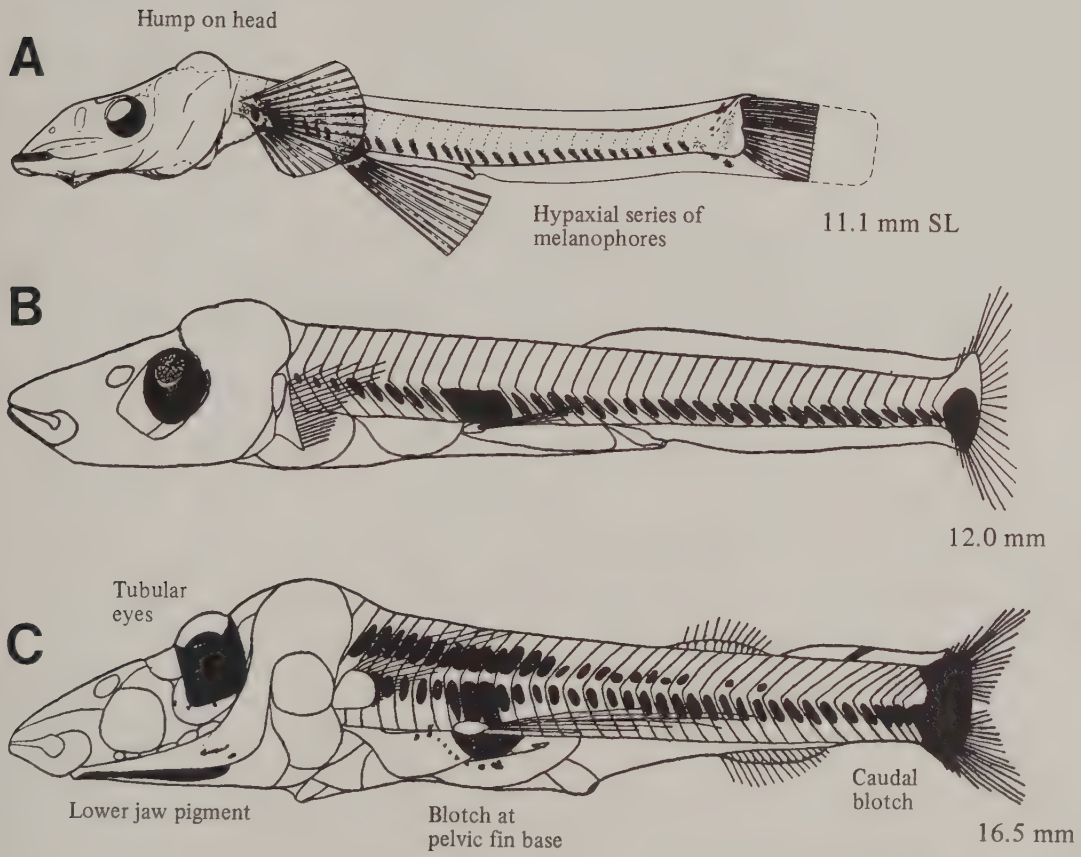



Figure A, NWAFC original (B. Vinter); B–C, Chapman 1939.

Members of the slickhead family are found worldwide in the deep sea, with six species in six genera found within the limits of this study area. Adults occur at depths of 45 to 5500 m but are primarily taken in hauls near the ocean bottom below 600 m. Juveniles occur in midwater (Fitch and Lavenberg 1968). Reproductive characteristics are unknown. Little information on alepocephalid early-life-history stages has appeared since Beebe (1933) in which they were found to hatch from large eggs (3-4 mm) and have direct development. There is no close relationship between alepocephalids and argentinoids because alepocephalids have large eggs, direct development, and share no specialized ontogenetic characters with argentinoids (Ahlstrom et al. 1984b).

**Table 6**
**Meristic characters of family Alepocephalidae.**

| | | Vertebrae | Fins | | | | Gill rakers | | |
|---|---|---|---|---|---|---|---|---|---|
| Taxon | Distribution | Precaudal (Total) Caudal | Dorsal | Anal | Pectoral | Pelvic | Upper | Lower | Branchiostegals |
| *Alepocephalus tenebrosus* | Cent. Calif.-Bering Sea | (53-55) | 17 | 17-18 | 10 | 6-7 | 7-8 | 17-18 | 6-7 |
| *Bathylaco nigricans* | SSC-Oregon | (45-46) | 17-22 | 11-12 | 6-11 | 6-9 | 3-5 | 8-13 | 9-10 |
| *Ericara salmoneum* | S. Calif.-Bering Sea | | 17-19 | 4-28 | 12 | 6 | | | 6 |
| *Leptochilichthys agassizi* | SSC-Oregon | | 14 | 13 | 11 | 10 | 8 | 19 | 13 |
| *Narcetes stomias* | SSC-Wash. | | 17-21 | 14-16 | 10-11 | 8-9 | 3-4 | 12-14 | 8 |
| *Talismania bifurcata** | SSC-Brit. Col. | 16-17 27-28 (43-46) | 22 | 21-23 | 10-12 | 6-7 | 7-8 | 15-18 | 7 |

*The NWAFC meristic database was updated by Sazonov 1981.

Tubeshoulders are found in all oceans, and five species in four genera are known in the Northeast Pacific Ocean and Bering Sea (Matsui and Rosenblatt 1987). Adults are commonly taken in midwater trawls but have been found at the surface (at night) to below 1000 m (Fitch and Lavenberg 1968). Little is known of their reproduction and early life history except that juveniles of *Sagamichthys abei* migrate upward at night to within 200 m of the surface to feed (Hart 1973).

**Table 7**
**Meristic characters of family Platytroctidae.***

| | | Vertebrae | | Fins | | | | Gill rakers | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Taxon | Distribution | Precaudal | Caudal (Total) | Dorsal | Anal | Pectoral | Pelvic | Upper | Lower | Branchiostegals |
| *Holtbyrnia innesi* | Bering Sea | 26-30 | 18-20 (46-48) | 18-19 | 17 | 16 | 9 | 7 | 15-16 | 8 |
| *Holtbyrnia latifrons* | SSC-Brit. Col. | 27-28 | 20 (46-50) | 17-20 | 14-16 | 16-20 | 8-9 | 6-8 | 17-19 | 8-9 |
| *Maulisia argipalla* | SSC-Bering Sea | 25-27 | 19-22 (46-47) | 17-20 | 15-17 | 18-19 | 7-8 | 7-8 | 16-18 | 8 |
| *Pellisolus eubranchus* | Oregon | 20-23 | 20-24 (42-44) | 17-19 | 15-16 | 18-21 | 6-8 | 5-6 | 17-18 | 8-9 |
| *Sagamichthys abei* | S. Calif.-Brit. Col. | 30-31 | 19-21 (50-52) | 16-18 | 14-16 | 14-18 | 9-10 | 7-8 | 16-18 | 6-8 |

*Taxonomy and meristic data from Matsui and Rosenblatt (1987). The northernmost record of *Mirorictus taningi* (reported also as *Normichthys campbelli*) is 35°N but it may occur further north.

Smelts are confined to the Northern Hemisphere, and seven species in six genera are found in the northeastern Pacific. Some species spawn intertidally, others are anadromous. Spawning is protracted and en masse. Spent fish return to deeper water except for *Thaleichthys pacificus*, which experiences high, though not complete, mortality after spawning (Garrison and Miller 1982). Osmerid eggs are generally 0.80-1.1 mm, strong to feebly adhesive, and have numerous oil globules. The adhesive membrane results from the rupturing of an outer "chorion" during spawning which turns out and onto the substrate (Hearne 1983, 1984). In general, larval characteristics include an elongate body shape, gut 75% of standard length, subterminal mouth, conspicuous choroid fissure, stalked pectorals, no dorsal melanophores, a single row of melanophores along the ventral midline of the gut, and a single row of melanophores on the ventral midline of the tail (Hearne 1984). All osmerid larvae possess a single midventral row of melanophores below the gut. *Spirinchus starksi* larvae have a greater number of ventral melanophores than *Spirinchus thaleichthys* or *Thaleichthys pacificus* (Hearne 1983). Myomere counts may be of additional use. Osmerids are the most abundant larvae in the nearshore waters (0-20 km) off Oregon; usually >50% of the larvae collected from January through June are osmerids (B. Mundy, NMFS Southwest Fish. Cent., Honolulu Lab., Honolulu, HI 96822-2396, pers. commun., 1 Oct. 1986.). Presently, it is possible to identify only one of these larvae to genus or species. A complete developmental series of *Mallotus villosus* is known. They are common in our ichthyoplankton collections off Oregon, Washington, and in the Gulf of Alaska.

**Table 8**
**Meristic characters of family Osmeridae.**

| Taxon | Distribution | Vertebrae | | Fins | | | | Gill rakers | | Branchiostegals |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Precaudal | Caudal (Total) | Dorsal | Anal | Pectoral | Pelvic | Upper | Lower (Total) | |
| *Allosmerus elongatus* | S. Calif.-Brit. Col. | 40-44 | 23-27 | 9-11 | 14-17 | 12-14 | 8 | 10-13 | 23-28 | 6-7 |
| *Hypomesus pretiosus* | S. Calif.-Bering Sea | 42-44 | 22-24 (62-70) | 8-11 | 12-17 | 14-17 | 8 | 10-13 | 21-25 | 7-8 |
| *Mallotus villosus* | Wash.-Arctic | | (62-73) | 10-14 | 16-23 | 16-21 | 9 | 8-13 | 24-35 | 7-8 |
| *Osmerus mordax* | Brit. Col.-Arctic | | (58-68) | 8-11 | 12-16 | 11-14 | 8 | 8-11 | 18-24 (26-37) | 6-8 |
| *Spirinchus starksi* | S. Calif.-SE Alaska | 33-36 | 25-29 | 8-11 | 15-21 | 10-11 | 8 | 8-13 | 24-31 | 7-8 |
| *Spirinchus thaleichthys* | Cent. Calif.-Bering Sea | 29-31 | 24-27 (54-61) | 8-10 | 15-22 | 10-12 | 8 | 10-13 | 26-34 | 7-8 |
| *Thaleichthys pacificus* | Cent. Calif.-Bering Sea | | (65-72) | 10-13 | 18-23 | 10-12 | 8 | 4-6 | 13-18 | 6-8 |

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 62-X-73 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 7-X-8 | |
| **Caudal fin** | X, 10+9, X | |
| **Pelvic fin** | Abdominal | |
| | R: 9-X-9 | |
| **Dorsal fin** | R: 10-X-14 | |
| **Pectoral fin** | R: 16-X-21 | |
| **Anal fin** | R: 16-X-23 | |
| **Gill rakers** | U: 8-X-13 | L: 24-X-35 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Washington, 46-48°30′N, to Arctic, not specific |
| **Ecology** | Nearshore shelf pelagic, 0-200 m;[a] 750 m[b] |
| **ELH pattern** | Oviparous, demersal attached eggs, pelagic larvae |
| **Spawning** | Season: Fall (British Columbia);[c] spring (Bering Sea)[d] |
| | Area: Gravel beaches[c] |
| | Mode: Schools[c] |
| | Migration: |
| **Fecundity** | Range/function: 3000-6600 (British Columbia)[c] |
| **Age at first maturity** | 2+ yr[e] |
| **Longevity** | >3 yr[f] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1 mm |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | Adhesive |
| **Hatch size** | 3-6 mm |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | ~75% SL |
| **Length at flexion** | After yolk absorption, ~7-8 mm SL |
| **Length at transformation** | |
| **Sequence of fin development** | Probably caudal, dorsal, anal, pelvics, pectorals |

**Pigment**

- Single row of melanophores along ventral gut midline
- Single row of postanal ventral melanophores developing into double row (ventral view)

**Diagnostic characters** (see Table 4)

Distinguished from clupeiforms by

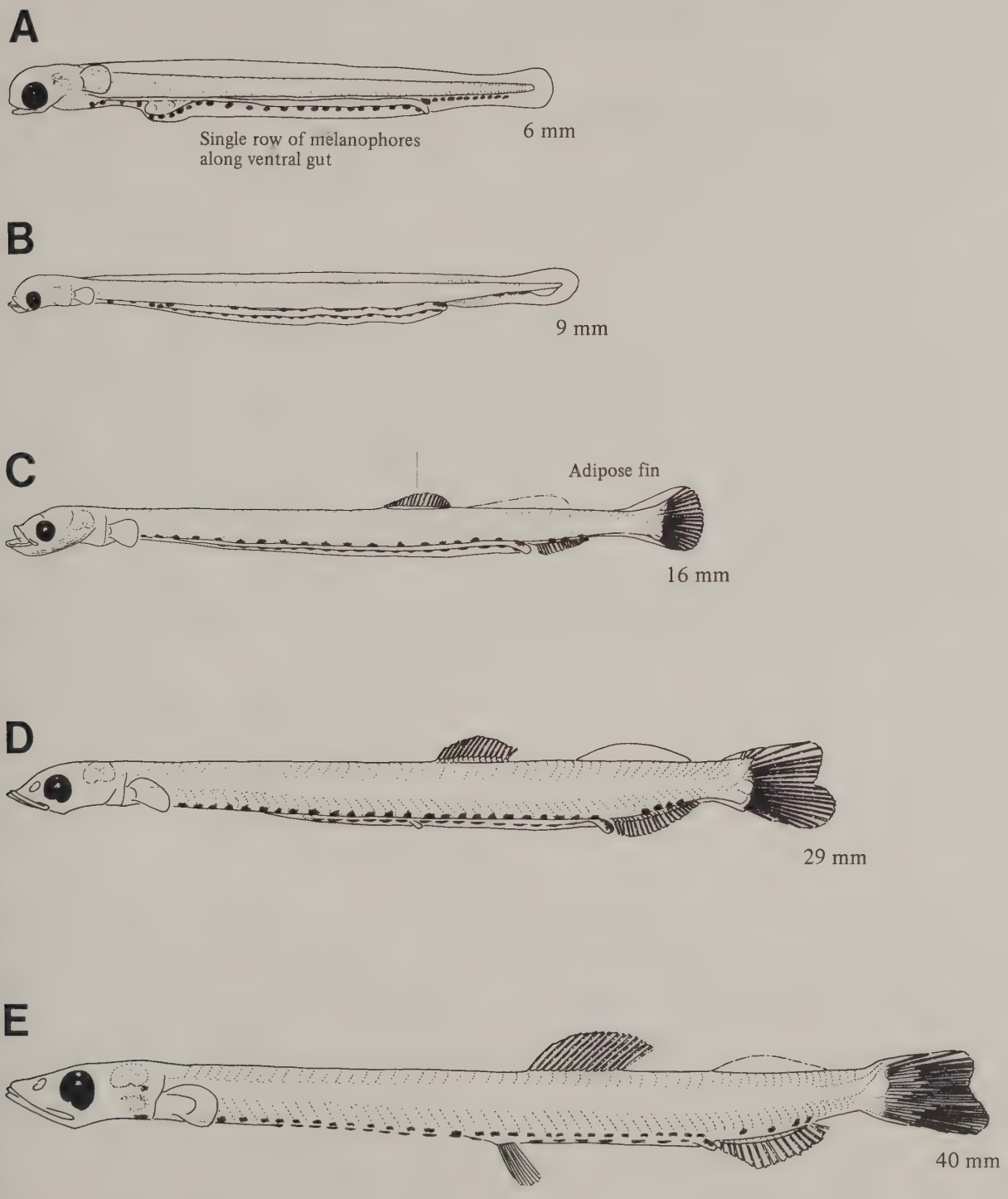
- Higher number of myomeres (62-73)
- Pigment: Single rather than double row of mid-ventral melanophores below gut
- Greater gut length (75% SL)
- Presence of adipose fin

Distinguished from other osmerids by

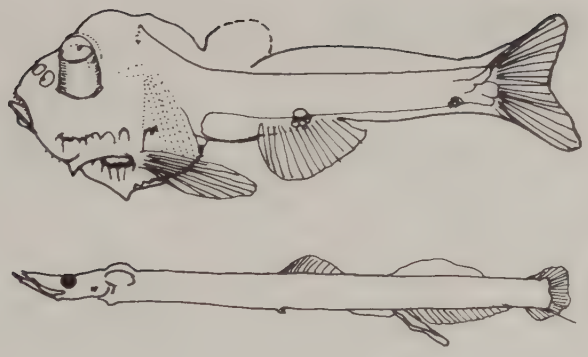
- Combination of greater number of pectoral fin rays (16-21) and anal fin rays (16-23)

[a] Andriashev 1954
[b] Allen and Smith 1988
[c] Hart and McHugh 1944
[d] Baxter 1975
[e] Trumble 1973
[f] Hart 1973

Ref: Templeman 1948.




Figures A–E, Fahay 1983 (A, after Bigelow and Schroeder 1953; B–E, after Templeman 1948; Atlantic specimens).



## Stomiiformes

Fishes of the order Stomiiformes are mostly tropical to temperate, with many being deep-sea. This highly diverse order contains 9 families, 53 genera, and about 248 species (J. Nelson 1984). A total of 6 families, 12 genera, and 22 species are found within the study area. Body forms among stomiiforms range from eel-like (idiacanthids) to deep and extremely compressed (sternoptychids). Most species have luminescent organs, teeth on both premaxilla and maxilla, mouth extending past the eye, an adipose fin, and a dark-brown or black color (primarily silver in Gonostomatidae and Sternoptychidae). Presently, there is no consensus on the relationships within the order (Weitzman 1974, Fink and Weitzman 1982, Ahlstrom et al. 1984c, Fink 1984). Herein, we treat the gonostomatids and sternoptychids together, and the chauliodontids, melanostomiids, malacosteids, and idiacanthids together. For convenience, we will call the former families the gonostomatoids, and the latter the stomioids, without phylogenetic implications. The identification of gonostomatoid larvae requires a knowledge of developmental data from larvae, juveniles, and adults (including fin rays, teeth, and photophores). Of importance are pigment patterns, position of dorsal and anal fins (caution must be used, since positions change with growth), presence of an adipose fin, and photophores (number, pattern, and sequence of development) (Ahlstrom et al. 1984c). In addition to pigment patterns and meristic and photophore characters, gut structure (trailing or not) is an important feature to consider in the identification of stomioids.

Families in study area: **Gonostomatidae**
**Sternoptychidae**
**Chauliodontidae**
**Melanostomiidae**
**Malacosteidae**
**Idiacanthidae**

## Table 9

**Definitions of alphabetical symbols used for designating photophores in deep-bodied sternoptychids and other stomiiform fishes (Ahlstrom et al. 1984c, in part).**

| Code | Definitions |
|---|---|
| **Gonostomatoids** | |
| SO | Symphyseal photophores (organs) located at tip of lower jaw. |
| Orb | Photophores associated with the eye located anterior and posterior of orbit. |
| Op | Photophores on opercle series generally three, coded as follows 1/(1+1). |
| Br (BRP) | Photophores located on the branchiostegal membranes. |
| Is (I) | Photophores located on the isthmus. |
| IP | Photophores of the ventral series found from the isthmus to the base of the pectoral fin. |
| PV | Photophores of the ventral series found from the pectoral fin base to the pelvic (ventral) fin base. |
| VAV | Photophores of the ventral series found from the pelvic (ventral) fin base to the anal fin base. |
| AC | Photophores of the ventral series found from the anal fin base to caudal fin base. |
| IC | Summary of photophores of the ventral series from the isthmus to caudal fin base (IP+PV+VAV+AC). |
| IV | Summary of photophores of the ventral series from isthmus to pelvic (ventral) fin base (IP+PV). |
| OV | Photophores of the lateral series from the opercle to pelvic (ventral) fin base. |
| VA (VALA) | Photophores of the lateral series from the pelvic (ventral) fin base to the anal fin base. |
| OAA | Summary of photophores of OV plus VA series. |
| OA (OAB) | Summary of lateral photophores from the opercle to anal fin base (OV+VA). |
| OAC (OC) | Entire lateral series on body sides just dorsal to ventral series and extending from opercular border, or just medial to it, over anal fin to caudal fin base. |
| ODM | Photophores (organs) found dorsal to the lateral midline (found only in *Gonostoma gracile*). |
| **Deep-bodied Sternoptychids** | |
| SO | Subopercle photophore which is equivalent to posteriormost photophore in opercular series of gonostomatoids. |
| PO | Photophore located anterior to orbit. |
| PTO | Photophore located posterior to orbit and may be equivalent to upper photophore of opercular series of gonostomatoids. |
| PRO | Preopercular photophore, used for PO photophore dorsal to ventral limb or preopercle. |
| Br | Same as gonostomatoid definition. |
| Is | Same as gonostomatoid definition. |
| AB | Photophores of ventral series located abdominally between pectoral fin base and pelvic fin base and equivalent to PV in gonostomatoids, plus a few posterior photophores of the IP series. |
| PAN | Photophores found anterior to anal fin and may be equivalent to VAV or VA in gonostomatoids. |
| AN | Photophores found above anal fin. |
| SC | Photophores found on lower (sub) caudal peduncle. Together with AN group may be equivalent to AC in gonostomatoids. |
| SAB | Photophores located above (supra) to the abdominal series and may be equivalent to VA in gonostomatoids. |
| SP | Photophores located above (supra) the pectoral fin and may be equivalent to OV in gonostomatoids. |
| SAN | Photophores located above (supra) to anal photophores and equivalent to part of AC series. |

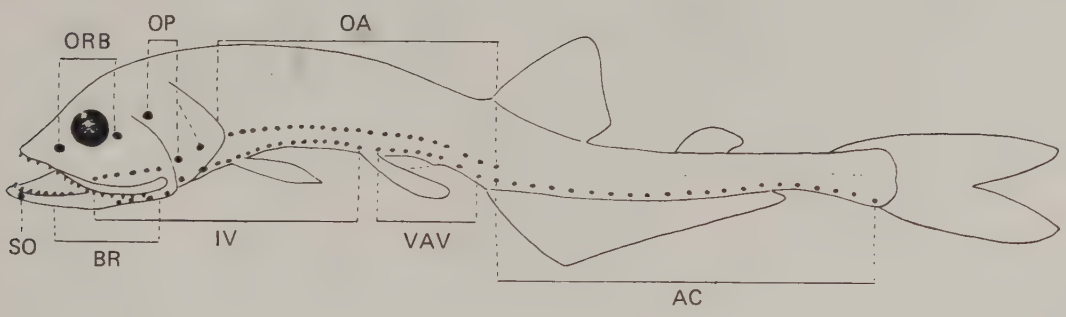
## Table 10

**Photophore distribution in selected gonostomatoid genera (Ahlstrom et al. 1984c, in part). See Table 9 for photophore definitions.**

| | No. of rows | SO | ORB | OP | BR | IS | IV | VAV | AC | Photophores in groups of glands? |
|---|---|---|---|---|---|---|---|---|---|---|
| *Argyropelecus* | 2 | No | 2 | 2 | 6 | Yes | 18 | 4 | 10 | Yes |
| *Cyclothone* | 2 | No | 1 | 2 | 8-11 | No | 12-14 | 4-5 | 12-16 | No |
| *Danaphos* | 2 | No | 1 | 2-3 | 6 | Yes | 18 | 5 | 22-26 | Yes |
| *Gonostoma* | 2 | Yes | 1 | 2-3 | 9 | No | 11-16 | 3-10 | 15-23 | No |
| *Sternoptyx* | 2 | No | 2 | 2 | 3 | Yes | 15 | 3 | 7 | Yes |

## MAJOR PHOTOPHORE GROUPS

**A** Gonostomatoid




**B** Sternoptychid

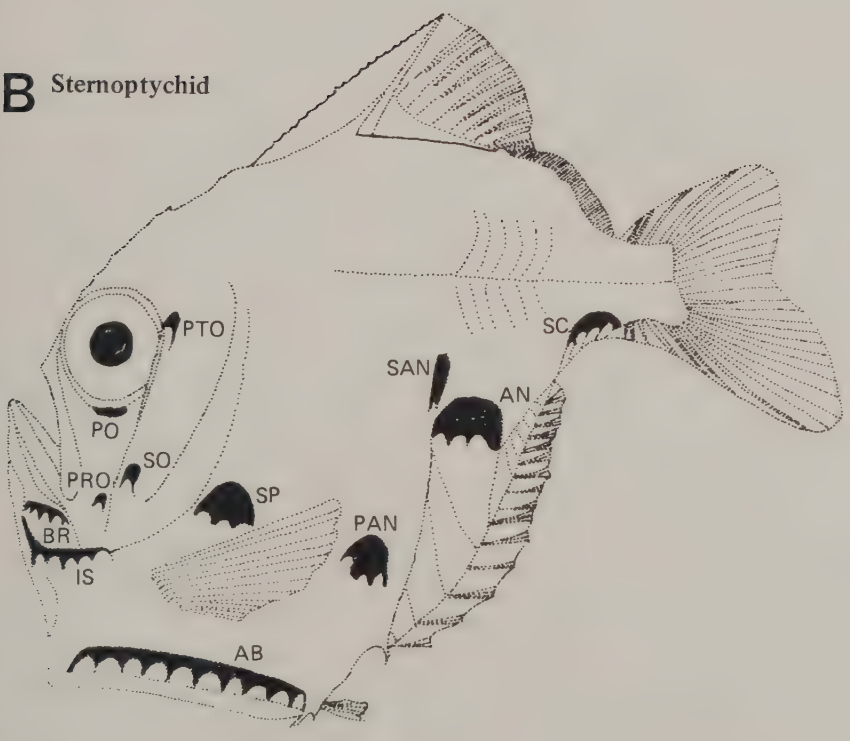



Figure A, Fahay 1983 (after Ozawa 1976); B, Badcock and Baird 1980 (redrawn).

**Table 11**

**Fin position and condition of adipose fin in selected gonostomatoid fishes (Ahlstrom et al. 1984c, in part).**

| Genera | Adult | Larvae | Adipose fin |
|---|---|---|---|
| *Argyropelecus* | Anal origin opposite last dorsal fin ray | Anal origin behind dorsal fin | Present or absent |
| *Cyclothone* | Anal origin opposite dorsal fin or slightly behind | Same as adult | Absent |
| *Danaphos* | Anal origin behind dorsal fin | Same as adult | Absent |
| *Gonostoma* | Anal origin opposite or 3-4 rays in advance of dorsal origin | Same as adult | Present or absent |
| *Sternoptyx* | Anal origin opposite dorsal origin | Anal origin behind dorsal fin | Present |

**Table 12**
**Meristic characters of family Gonostomatidae.**

| Taxon | Distribution | Vertebrae | | Fins | | | | | Gill rakers | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Precaudal (Total) | Caudal | Dorsal | Anal | Pectoral | Pelvic | Caudal | Upper | Lower | Branchiostegals |
| *Cyclothone acclinidens* | SSC-Oregon | 13-14 | 17-19 | 13-15 | 18-20 | 9-10 | 6 | 6,10+9,6[a] | 6-9 | 14-17 | 13-15 |
| *Cyclothone atraria* | SSC-Bering Sea[b] | 12-13 | 18-20 | 13-15 | 18-21 | 9-10 | 6 | | 6-8 | 13-16 | 12-14 |
| *Cyclothone pallida* | SSC-Brit. Col. | 13-14 | 17-21 | 13-15 | 17-19 | 9-11 | 6-7 | | 7-10 | 14-18 | 13-15 |
| *Cyclothone pseudopallida* | SSC-Bering Sea | 12-13[a] | 18-20[a] | 13-15 | 18-21 | 9-10 | 6 | | 4-6 | 12-14 | 13-15 |
| *Cyclothone signata* | SSC-Gulf of Alaska | 13 | 17-19 | 13-14 | 18-20 | 9-10 | 6 | 6-8,10+9,6-7[a] | 3-5 | 10-11 | 12-14 |
| *Gonostoma atlanticum* | SSC-Oregon | (38-39) | | 16-18 | 27-30 | 9-10 | 6-7 | | 6-7 | 11 | 11-12 |
| *Gonostoma gracile* | Gulf of Alaska-Bering Sea | 18-19 | 22-24 | 9-12 | 22-30 | 8-10 | 6-8 | | | | 11-12 |

[a] E.H. Ahlstrom notes
[b] Records from north of British Columbia are questionable (A.E. Peden, Brit. Col. Prov. Mus., Victoria, B.C., Canada V8V 1X4, pers. commun., 22 Jan. 1987).

This worldwide genus of lightfishes may constitute the most abundant genus of fish in the sea. These small (to 80 mm) bathypelagic fishes are found most commonly at depths of 300 m and greater and have been found as deep as 5300 m. Very little information on life history is available. The eggs are unknown but larvae are common in offshore tropical and temperate areas. *Cyclothone* spp. larvae are discussed at the generic level since only partial series are available for the five species in the study area. Gorbunova (1982a) described the larvae of eight species from the Pacific including four from the study area (all species except *C. atraria*). The descriptions of *C. acclinidens*, *C. pallida*, and *C. pseudopallida* by Gorbunova (1982a) have been questioned by Ozawa and Oda (1986) who described the larvae (>7 mm SL) of five species of *Cyclothone* (all species from the study area except *C. signata*). Since preflexion larvae and transforming larvae linking larval series to adults are generally unavailable, Ozawa and Oda (1986) discussed the need for further investigation.

Preanal length for *Cyclothone* spp. larvae is about 50% SL. Lengths at flexion and transformation are 4-5 mm SL and about 14 mm SL, respectively. Caudal and dorsal fins form first, followed in sequence by the anal, pelvic, and pectoral fins. Photophores are described in Table 10.

Pigment characters for *Cyclothone* spp., based on described species, include
- 2-3 spots along gut with posteriormost spot at anus (sometimes more spots in larger specimens)
- One spot at cleithral symphysis
- Pigment on swimbladder
- Lateral series posterior to pectoral fins, ending prior to swimbladder
- Series over anal fin base (varies from ~5-12 spots and may or may not be evenly spaced; number and spacing of series may be species-specific)
- Some species develop dorsal series similar to anal base series
- Spots at base of anal fin pterygiophores
- Spots usually appear above and below urostyle and in hypural area

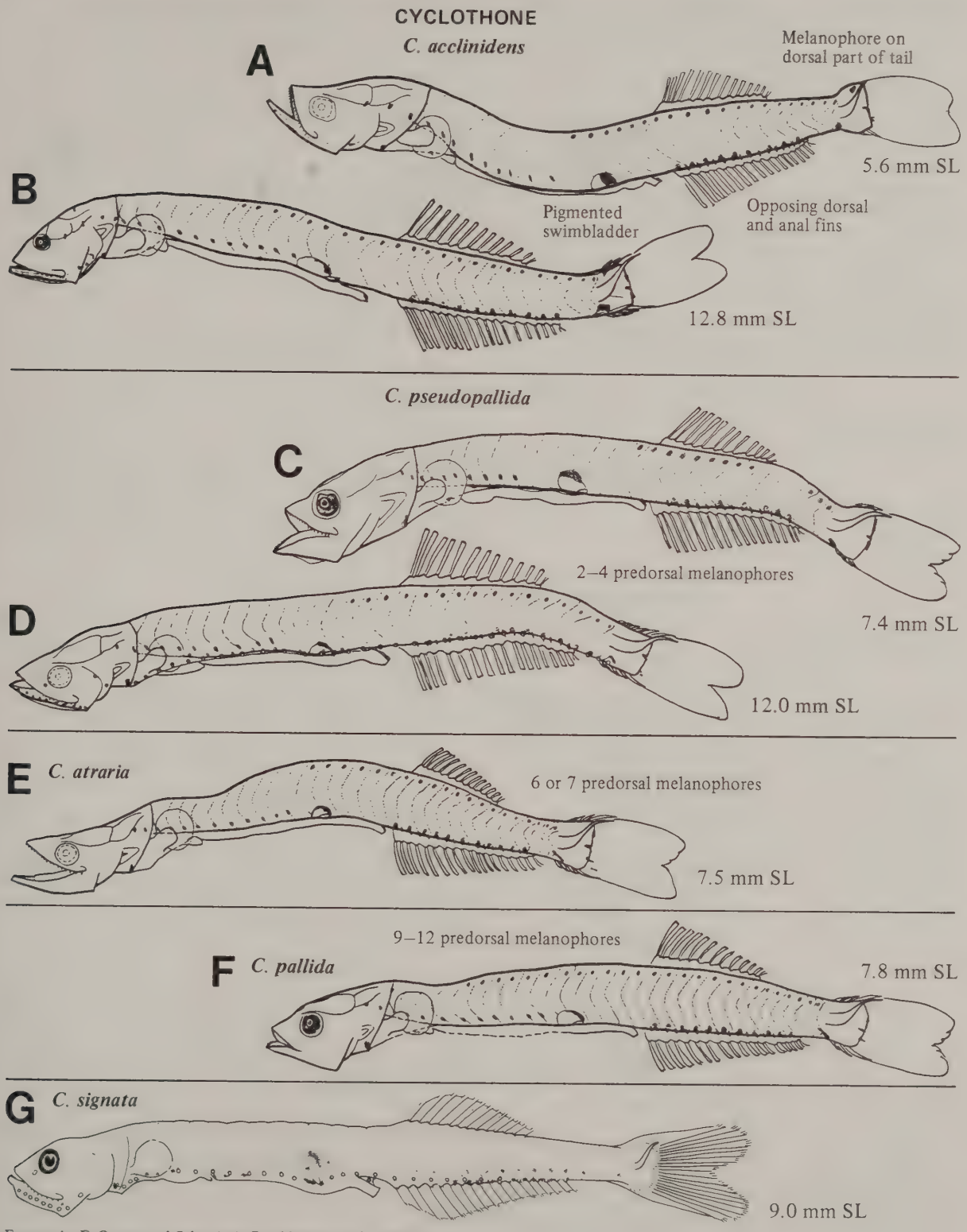
Diagnostic characters for *Cyclothone* spp. larvae include
- Distinct dark streak or intense melanophore over and parallel to parhypural on caudal fin base
- Pigmentation over gut and along ventral margin of tail
- Anal fin origin opposite dorsal fin or slightly behind (no ontogenetic movement)
- Conspicuous swimbladder
- No adipose fin
- Larvae generally elongate

Diagnostic characters for species
- *C. acclinidens* (melanophore on dorsal part of tail end)
- *C. pseudopallida* (predorsal melanophores 2-4, see figure)
- *C. atraria* (predorsal melanophores 6 or 7, see figure)
- *C. pallida* (predorsal melanophores 9-12, see figure)
- *C. signata* (no melanophore on dorsal part of tail end, and no predorsal melanophores)

Distinguish from *Gonostoma*
- See Tables 10-12
- Fewer anal fin rays (16-21 vs. 21-31)
- Fewer vertebrae (29-33 vs. 37-40)
- SO photophore absent
- Caudal pigment (present in *Gonostoma atlanticum* but not in *G. gracile*)

Larger postflexion larvae, which differ greatly from adults, undergo a metamorphic stage during which most of the photophores become pigmented simultaneously, the anterior portion of the body shortens, and the anus changes position from near the anal fin to nearer the ventral fin bases.

Ref: Ahlstrom et al. 1984c; Fahay 1983; Gorbunova 1982a; Grey 1964; Hart 1973; Jespersen and Tåning 1926; Mukacheva 1954, 1964; Ozawa and Oda 1986.




Figures A–F, Ozawa and Oda 1986; G, Ahlstrom et al. 1984c.

## MERISTICS *G. atlanticum* Norman 1930

| | | |
|---|---|---|
| **Vertebrae** | Total: 38-X-39 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 11-X-12 | |
| **Pelvic fin** | Abdominal | |
| | R: 6-7-7 | |
| **Dorsal fin** | R: 16-18-18 | |
| **Pectoral fin** | R: 9-X-10 | |
| **Anal fin** | R: 27-28-30 | |
| **Gill rakers** | U: 6-X-7 | L: 11-X-11 |

## MERISTICS *G. gracile* Günther 1878

| | | |
|---|---|---|
| **Vertebrae** | Total: 40-X-42 | |
| | Precaudal: 18-X-19 | |
| | Caudal: 22-X-24 | |
| **Branchiostegal rays** | 11-X-12 | |
| **Pelvic fin** | Abdominal | |
| | R: 6-X-8 | |
| **Dorsal fin** | R: 9-X-14 | |
| **Pectoral fin** | R: 8-X-11 | |
| **Anal fin** | R: 22-X-30 | |
| **Gill rakers** | U: 7-8-8 | L: 12-13-14 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | |
| (*G. atlanticum*) | South of southern California to Oregon, 42-46°N |
| (*G. gracile*) | Gulf of Alaska, 54-60°N to Bering Sea, 54-66°N |
| **Ecology** | Meso- and bathypelagic[a] |
| **ELH pattern** | Oviparous, pelagic larvae |
| **Spawning**[b] | Season: Sept-Apr (Japan) |
| **Age at first maturity**[b] | 1 yr (males - then undergo sex reversal at 70-80 mm SL) |
| **Longevity**[b] | 2 yr (females)<br>1 yr (males) |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS (*G. denudatum*)

| | |
|---|---|
| **Diameter** | 0.80-0.81 mm |
| **No. of oil globules** | One |
| **Oil globule diameter** | 0.20-0.21 mm |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE (*G. gracile*)

| | |
|---|---|
| **Preanal length** | |
| **Length at flexion** | |
| **Length at transformation** | |
| **Sequence of fin development** | Caudal, dorsal and anal, pectorals and pelvics |

**Pigment**

- Internal head pigment
- Swimbladder and peritoneum

**Diagnostic characters**

*G. gracile* distinguished from other *Gonostoma* spp. by

- Anal fin origin extremely in advance of dorsal fin origin

*G. gracile* distinguished from *G. atlanticum* by

- Lack of pigment on caudal peduncle and body surface

*G. atlanticum* distinguished from *Cyclothone* spp. by

- Caudal and ventral pigment
- Swimbladder position

Photophores (see Table 10)

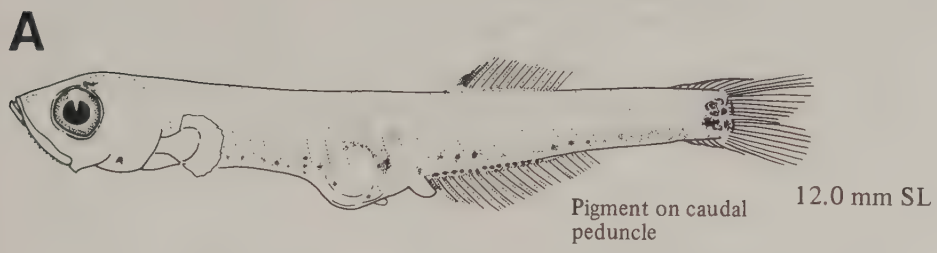
In *G. gracile* and *G. atlanticum*, photophores develop as a group. This differs from other species of *Gonostoma* where photophores develop gradually.

[a] *G. atlanticum* mesopelagic only.
[b] *G. gracile* only.

Ref: Ahlstrom 1974, Ahlstrom et al. 1984c, Kawaguchi and Marumo 1967, Ozawa 1986b, Sanzo 1931a.

***GONOSTOMA***

*Gonostoma atlanticum*




*Gonostoma gracile*

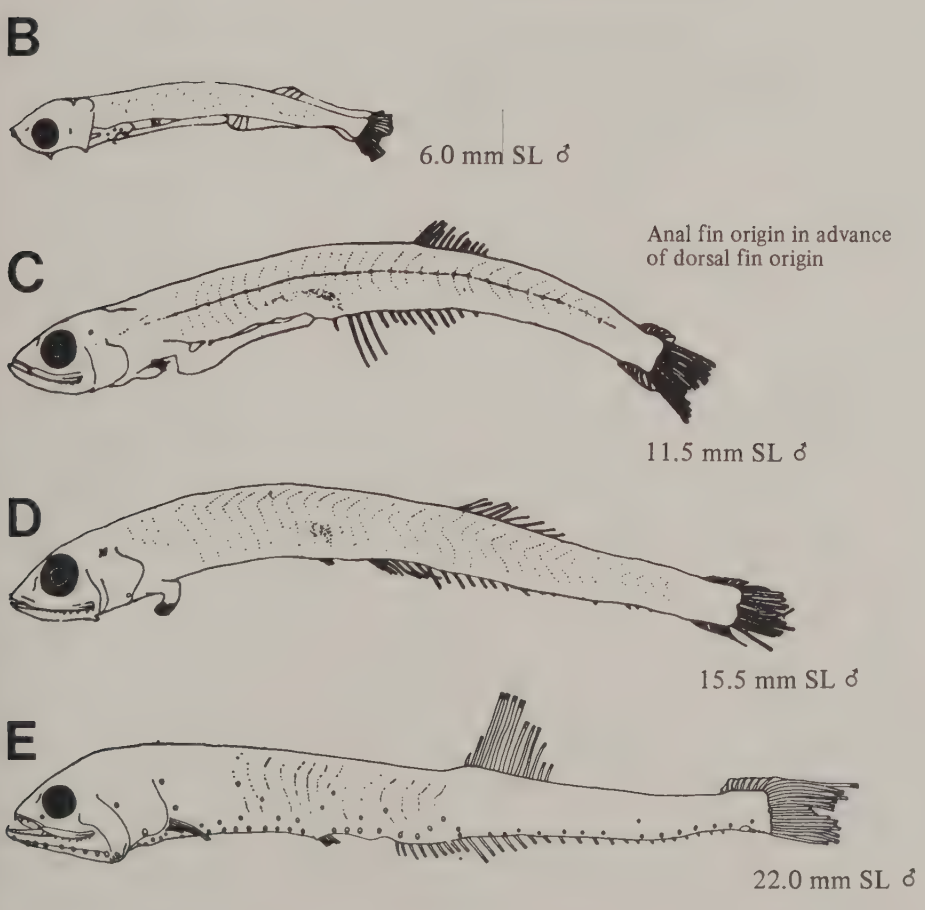



Figure A, Ahlstrom et al. 1984c (after Ahlstrom 1974); B–E, Kawaguchi and Marumo 1967 (western Pacific specimens).

# STERNOPTYCHIDAE

Found in all temperate and tropical seas, hatchetfishes are represented in the northeastern Pacific by seven species in three genera. Adults are found 100-5000 m below the surface (Schultz 1961). Sternoptychid eggs and larvae are planktonic, constituting the third most abundant family in the ichthyoplankton of open ocean waters (after myctophids and gonostomatids) (Ahlstrom 1972, Loeb 1979). *Argyropelecus hemigymnus* has eggs ranging from 0.92 to 1.04 mm. The yolk is coarsely segmented and contains one oil globule (Ahlstrom 1974). Development of sternoptychids is distinctly divided into two periods (Sanzo 1935): Larval period, and the period of metamorphosis marked by a sharp reduction in body length, change in shape, and photophore and fin-ray development. Distribution and patterns of photophores, especially their sequence of development, are instrumental in larval identification. The following characters may aid in distinguishing between the three sternoptychid genera in the study area (see Tables 13-14).

| | *Argyropelecus* | *Danaphos* | *Sternoptyx* |
|---|---|---|---|
| Anal fin rays | 11-13 | 24-25 | 14-16 |
| Pectoral fin rays | 10-11 | 13-14 | 10-11 |
| Vertebrae | 34-40 | 38 | 28-31 |
| Adipose fin | Present/absent | Absent | Absent |
| Photophores | | | |
| Br | 6 | 6 | 3 |
| Orb | 2 | 1 | 2 |
| IV | 18 | 18 | 15 |
| VAV | 4 | 5 | 3 |
| AC | 10 | 22-26 | 7 |

**Table 13**
**Meristic characters of family Sternoptychidae.**

| Taxon | Distribution | Vertebrae | Fins | | | | | Gill rakers | | Branchiostegals |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Precaudal Caudal (Total) | Dorsal | Anal | Pectoral | Pelvic | Caudal | Upper (Total) | Lower | |
| *Argyropelecus affinis* | SSC-Oregon | (39-41) | 9 | 12-13 | 10-11 | 6 | 10-12,10+9,4 | (18-22) | | 10 |
| *Argyropelecus hemigymnus* | SSC-Wash. | (37-39) | 8 | 11 | 10-11 | 6 | 10,10+9,5 | (18-24) | | 10 |
| *Argyropelecus lychnus* | SSC-Brit. Col. | (35-37) | 9 | 12 | 10-11 | 6 | 9-11,10+9,6 | 8-9 | 12-14 | 10 |
| *Argyropelecus sladeni* | SSC-Oregon | (36-38) | 9 | 12 | 10-11 | 6 | 10,10+9,6 | (17-21) | | 10 |
| *Danaphos oculatus* | SSC-Brit. Col. | (38) | 6 | 24-25 | 10-11 | | 8,10+9,3 | 2 | 11-13 | 10 |
| *Sternoptyx diaphana* | SSC-Oregon | (28-30) | 9-11 | 13-16 | 10-11 | | | 6-9 | | 6 |
| *Sternoptyx pseudobscura* | SSC-Brit. Col. | (27-30) | 9-11 | 13-15 | 10-11 | | | 7-9 | | 6 |

**Table 14**
**Characters useful in separating larvae of *Argyropelecus* found in the Northeast Pacific (Belyanina 1984, in part).**

| Character | *A. affinis* | *A. hemigymnus* | *A. lychnus* | *A. sladeni* |
|---|---|---|---|---|
| Photophores: SAB, PAN, AN, SC in a continuous row* | Yes | No | No | No |
| Caudal pigment | At or before transformation (~8 mm SL) | At or before transformation (~8 mm SL) | No | >13 mm SL |
| Number of postabdominal spines | 2 | 1 (posterior one reduced) | 2 | 2 |
| Number of dorsal fin rays | 9 | 8 | 9 | 9 |
| Eye shape (telescopic) | Round | Cylindrical | Round | Round |
| Presence of well-developed upper preopercular spine | No | No | Yes (pointed downward) | Yes (pointed upward) |
| Presence of frontal crest | No | No | Yes | Yes |

*See Table 9 for definitions of symbols.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 39-X-41 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 10-10-10 |
| **Caudal fin** | 10-12, 10+9, 4 |
| **Pelvic fin** | Abdominal |
| | R: 6-6-6 |
| **Dorsal fin** | R: 9-9-9 |
| **Pectoral fin** | R: 10-11-11 |
| **Anal fin** | R: 12-X-13 |
| **Gill rakers** | U: X-X-X L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Oregon, 42-46°N |
| **Ecology** | Epi- and mesopelagic, 100-610 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL increasing with development to ~50% SL |
| **Length at flexion** | |
| **Length at transformation** | <8.1 mm SL |
| **Sequence of fin development** | Caudal and pectorals, dorsal and anal, pelvics |

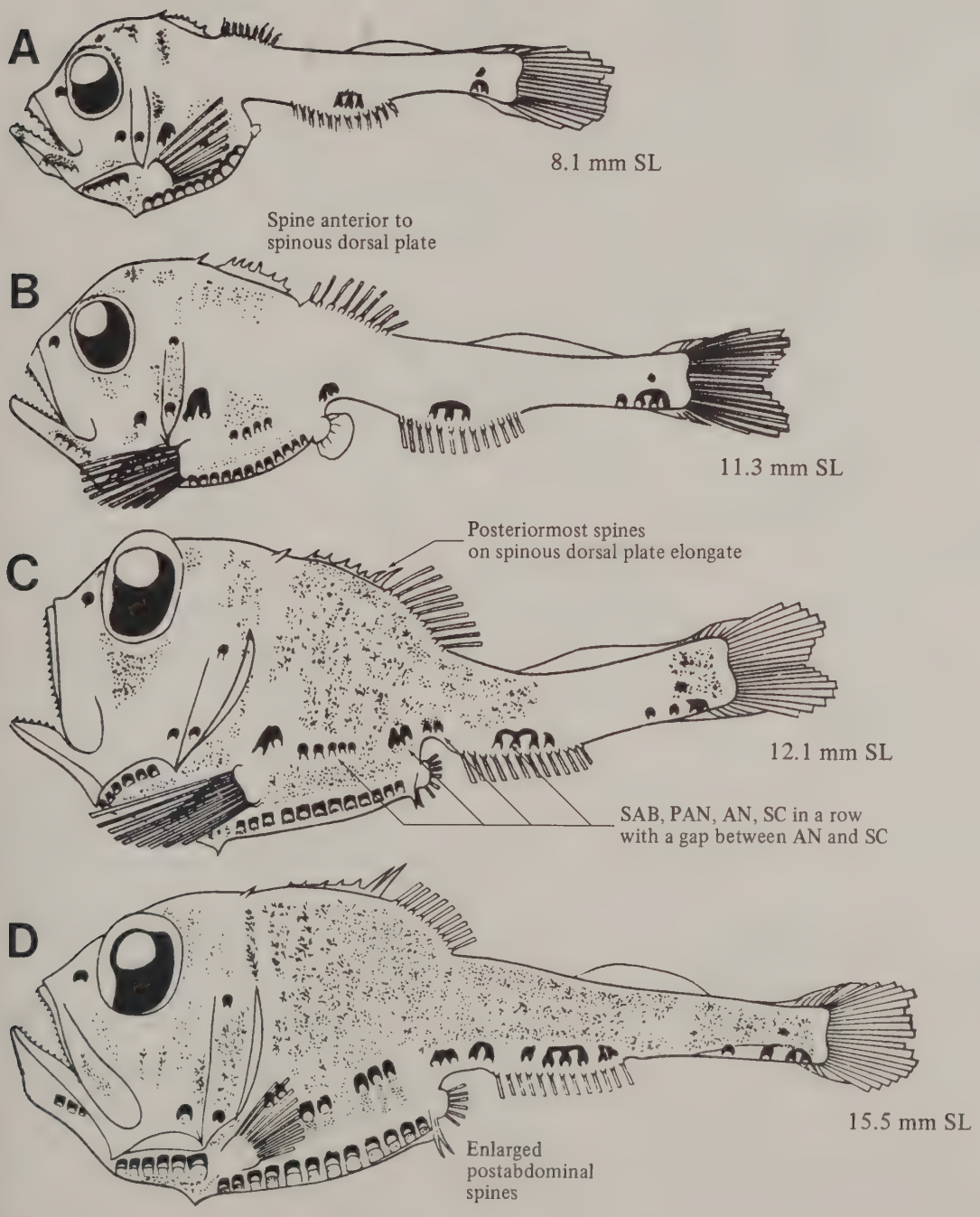
**Pigment**

- Initially, lightly pigmented on anterior body, increases posteriorly with development
- Characteristic spot occurs on caudal peduncle above subcaudal photophores; in larvae >11 mm SL, spot increases to a patch

**Diagnostic characters**

- Photophores: *A. affinis* distinguished by the location of supra-abdominal (SAB), preanal (PAN), anal (AN), and subcaudal (SC) photophores in a continuous straight line; AN and SC groups are separated by a gap
- Eyes telescopic
- Spines
  - —At 8 mm SL, a spine anterior to spinous dorsal plate
  - —At 11 mm SL, long posteriormost spine on spinous dorsal plate
  - —At >11 mm SL, enlarged postabdominal spines

Ref: Ahlstrom et al. 1984c, Belyanina 1984.




Figures A–D, Belyanina 1984.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 37-X-39 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 10-10-10 | |
| **Caudal fin** | 10, 10+9, 5 | |
| **Pelvic fin** | Abdominal | |
| | R: 6-6-6 | |
| **Dorsal fin** | R: 8-8-8 | |
| **Pectoral fin** | R: 10-X-11 | |
| **Anal fin** | R: 11-11-11 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Washington, 46-48°30′N |
| **Ecology** | Epi- and mesopelagic, 100-731 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 0.92-1.04 mm |
| **No. of oil globules** | One |
| **Oil globule diameter** | 0.26-0.28 mm |
| **Yolk** | Segmented |
| **Envelope** | |
| **Hatch size** | 2.5 mm SL; yolk absorbed 4.7 mm SL |
| **Incubation time/temp.** | 2-2.5 d (temperature unknown) |

**Pigment**

- Embryo unpigmented

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL increasing with development to ~50% SL |
| **Length at flexion** | |
| **Length at transformation** | >6 mm SL; body shrinks 2-3 mm, gut shortens, head deepens, and eyes become telescopic |
| **Sequence of fin development** | Caudal and pectorals, dorsal and anal, pelvics |

**Pigment**

- Unpigmented at hatching (except eyes) and through transformation
- After transformation, pigment appears on head in patches and on caudal peduncle

**Diagnostic characters**

- Elongate compressed body
- Photophores and sequence of development (~6-10 mm SL): Lower OP, BR, posterior IV, anterior IV, posterior AC, anterior AC, OA, ORB, and VAV
- SAB, PAN, AN, and SC photophores not in continuous row
- Postabdominal spines: In larvae >10-12 mm SL, anterior spine becomes thinner and elongated and bends under the posterior spine; posterior spine gradually reduces and becomes spur-shaped
- Number of dorsal fin rays (eight); other sternoptychids usually have nine
- Eye shape more cylindrical than other *Argyropelecus* spp.

Ref: Ahlstrom et al. 1984c, Belyanina 1984, Fahay 1983, Sanzo 1931a.

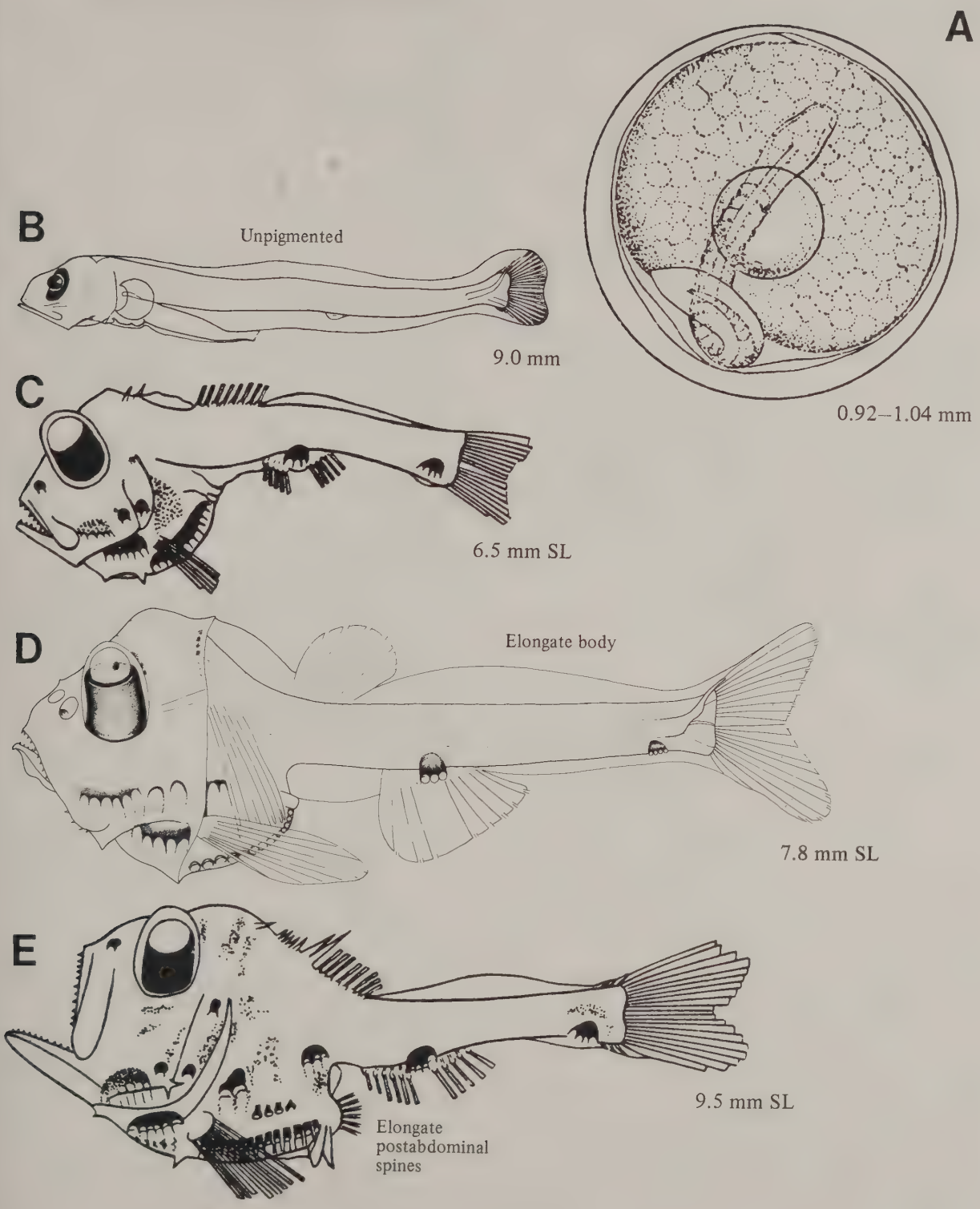



Figure A, Sanzo 1931a; B, Jespersen and Taning 1926; C, E, Belyanina 1984; D, Ahlstrom et al. 1984c (after Sanzo 1931a; A–B, D, Mediterranean specimens).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 35-X-37 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 10-10-10 |
| **Caudal fin** | 9-11, 10+9, 6 |
| **Pelvic fin** | Abdominal |
| | R: 6-6-6 |
| **Dorsal fin** | R: 9-9-9 |
| **Pectoral fin** | R: 10-X-11 |
| **Anal fin** | R: 12-12-12 |
| **Gill rakers** | U: 8-X-9 L: 12-X-14 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Brit. Col., 48°30′-55°N |
| **Ecology** | Epi-, meso-, and bathypelagic, 198-396 m; 4066 m[a] |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 50-60% SL |
| **Length at flexion** | |
| **Length at transformation** | |
| **Sequence of fin development** | Caudal and pectorals, dorsal and anal, pelvics |

**Pigment**

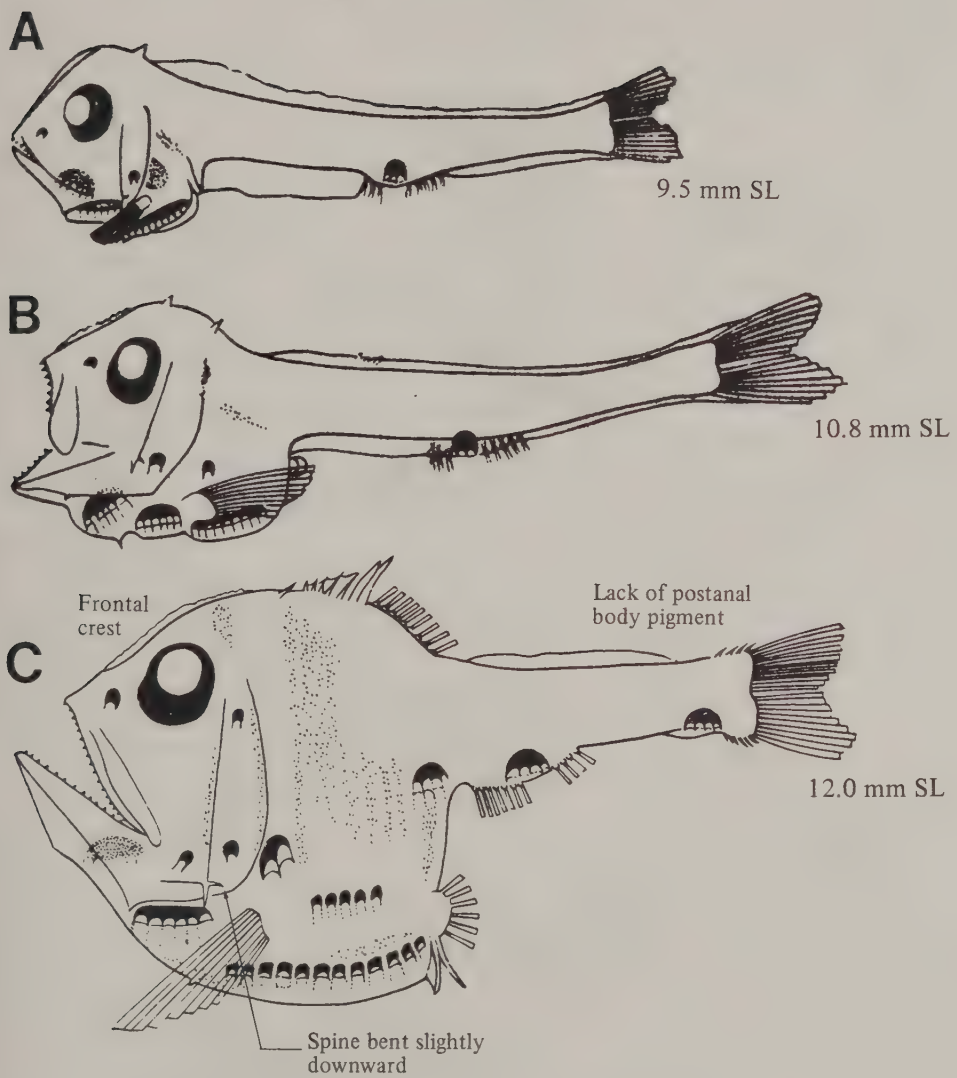
- Lightly pigmented, restricted to preanal body

**Diagnostic characters**

- Upper preopercular spine bent downward whereas same spine in *A. sladeni* is pointed slightly upward
- Pigmentation: Specimens described to 15 mm SL appear to lack pigment on postanal body, specifically in the peduncle area
- Presence of frontal crest

[a] Hart 1973

Ref: Ahlstrom et al. 1984c, Belyanina 1984.




Figures A–C, Belyanina 1984.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 36-X-38 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 10-10-10 |
| **Caudal fin** | 10, 10+9, 6 |
| **Pelvic fin** | Abdominal |
| | R: 6-6-6 |
| **Dorsal fin** | R: 9-9-9 |
| **Pectoral fin** | R: 10-X-11 |
| **Anal fin** | R: 12-12-12 |
| **Gill rakers** | U: X-X-X L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Oregon, 42-46°N |
| **Ecology** | Epi- and mesopelagic, 101-610 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 50-60% SL |
| **Length at flexion** | |
| **Length at transformation** | |
| **Sequence of fin development** | Caudal and pectorals, dorsal and anal, pelvics |

**Pigment**

- Initially, appears anteriorly on body in patches and, with development, increases posteriorly
- Spot on peduncle does not appear as early as *A. affinis*, first appearing as a patch in larvae >13 mm SL

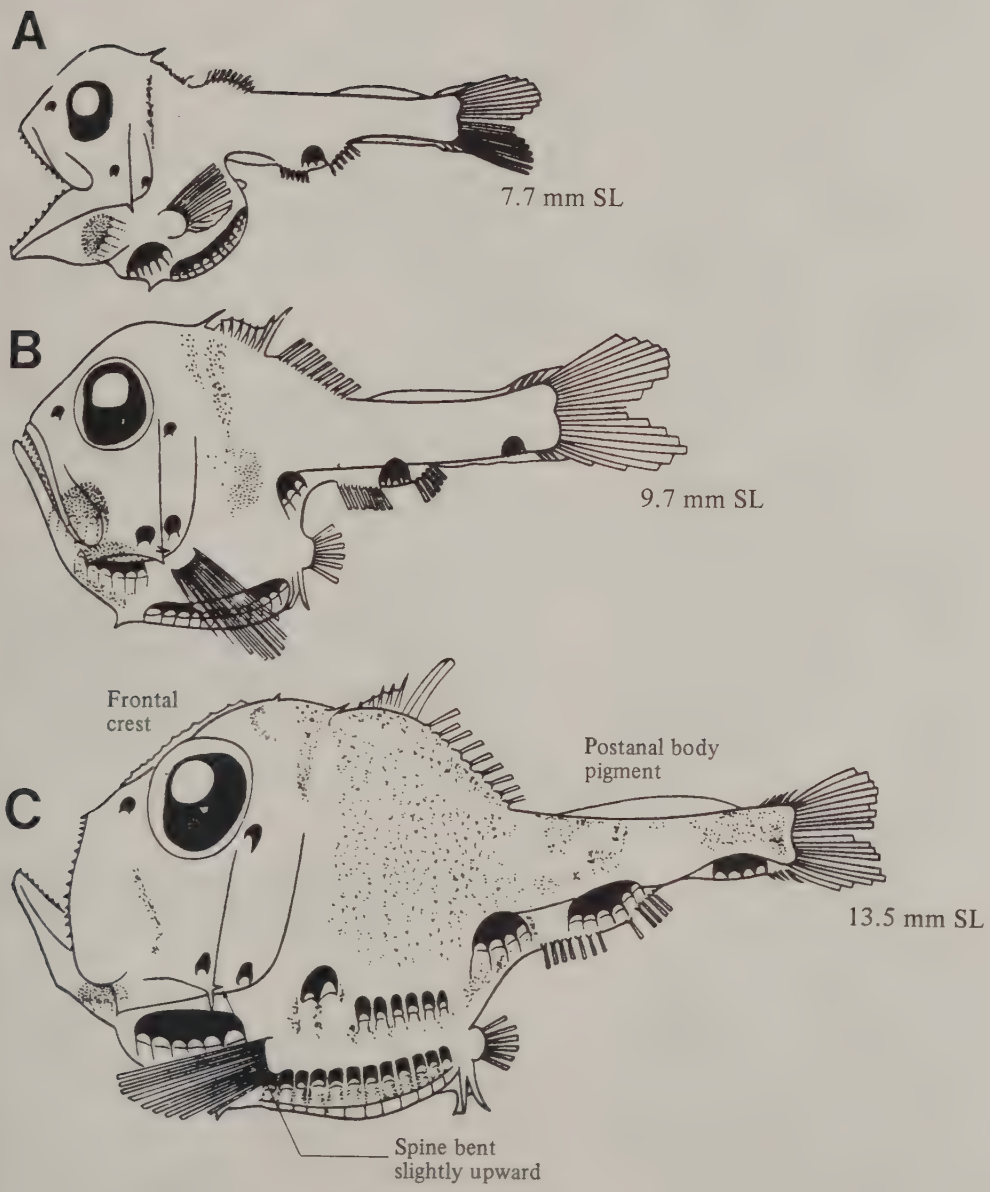
**Diagnostic characters**

- Spines: Upper preopercular spine is developed (pointed slightly upward) and short frontal crests are present

Distinguished from *A. affinis* and *A. hemigymnus* by

- Combination of nine dorsal spines and SAB, PAN, AN, and SC photophores not in continuous line

Ref: Ahlstrom et al. 1984c, Belyanina 1984.




Figures A–C, Belyanina 1984.

## MERISTICS *S. diaphana* Hermann 1781

| | | |
|---|---|---|
| **Vertebrae** | Total: 28-29-30 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 6-6-6 | |
| **Pelvic fin** | Abdominal | |
| | R: X-X-X | |
| **Dorsal fin** | R: 9-10-11 | |
| **Pectoral fin** | R: 10-X-11 | |
| **Anal fin** | R: 13-14-16 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## MERISTICS *S. pseudobscura* Baird 1971

| | | |
|---|---|---|
| **Vertebrae** | Total: 27-29-30 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 6-6-6 | |
| **Pelvic fin** | Abdominal | |
| | R: X-X-X | |
| **Dorsal fin** | R: 9-10-11 | |
| **Pectoral fin** | R: 10-X-11 | |
| **Anal fin** | R: 13-14-15 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Brit. Col., 48°30′-55°N[a] |
| **Ecology** | Meso- and bathypelagic |
| **ELH pattern** | Oviparous, eggs probably pelagic, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE - Genus[b]

| | |
|---|---|
| **Preanal length** | |
| **Length at flexion** | |
| **Length at transformation** | 6-14 mm SL[c] |
| **Sequence of fin development** | Pectorals and caudal, anal, dorsal and pelvics |

**Pigment**

- Head and tip of lower jaw
- Peritoneum, becoming embedded with development
- Presence/absence of pigment on caudal peduncle; according to Belyanina (1983) some specimens of *S. diaphana* have pigment whereas specimens of *S. pseudobscura* have none[d]

**Diagnostic characters**

- Prior to metamorphosis, larvae of the two species are indistinguishable; both with spiny ridges on frontal and parietal bones, opercular and post-temporal spines

Distinguish *S. pseudobscura* juveniles from *S. diaphana* by

- Rounder body
- Posterior anal pterygiophores longer
- SAN higher in position

Photophores (see Table 10)
Order of development in *Sternoptyx* spp. larvae: SO, Br2, AB7, I4, SP3, PTO, AN1 followed by PAN, SC, PRO, and SAN in early juveniles; finally SC.

[a] *S. diaphana* only to Oregon, 42-46°N.
[b] Although not well documented, geographic variation among and within species is clearly present.
[c] A dramatic change in morphology occurs at transformation. Elongate larvae become deep-bodied juveniles. Body length cannot be associated with development.
[d] Badcock and Baird (1980) cite a personal communication from E.H. Ahlstrom stating that neither of the two forms of *Sternoptyx* spp. from the study area have caudal pigment. A figure of *S. pseudodiaphana* is provided as an example of an early larva with caudal pigment.

Ref: Badcock and Baird 1980, Belyanina 1983.

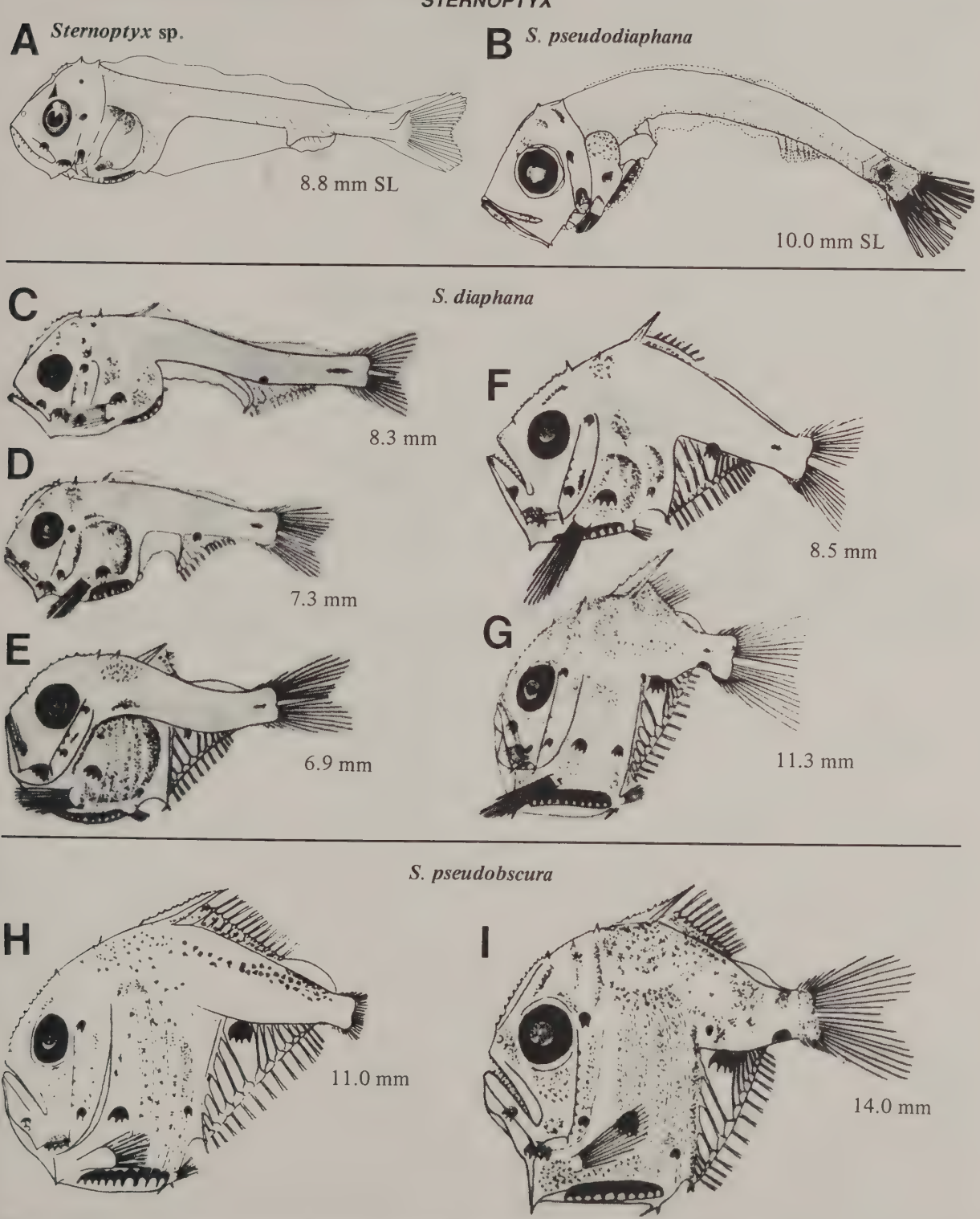



Figure A, Ahlstrom et al. 1984c; B, Badcock and Baird 1980 (eastern North Atlantic specimen); C–I, Belyanina 1984.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 38-38-38 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 10-10-10 | |
| **Caudal fin** | 8, 10+9, 3 | |
| **Pelvic fin** | Abdominal | |
| | R: X-X-X | |
| **Dorsal fin** | R: 6-6-6 | |
| **Pectoral fin** | R: 10-X-14 | |
| **Anal fin** | R: 24-X-25 | |
| **Gill rakers** | U: 2-2-2 | L: 11-X-13 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Brit. Col., 48°30′-55°N |
| **Ecology** | Mesopelagic, 183-914 m |
| **ELH pattern** | Oviparous, eggs probably pelagic, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL (short gut) |
| **Length at flexion** | |
| **Length at transformation** | ~45-50 mm SL |
| **Sequence of fin development** | |

**Pigment**

- Concentrated on preanal body in area below eye and over gut; smaller larvae generally unpigmented except over peritoneum

**Diagnostic characters**

- Larvae elongate
- Photophores begin formation ~16.5 mm SL (see Table 15)
- Photophores in clusters with common bases
- Metamorphosis gradual with the initial formation of photophores in the BR and PV groups

Distinguished from *Argyropelecus* spp. and *Sternoptyx* spp. by

- Long anal fin (24-25 fin rays) and short dorsal fin (6 fin rays)

Ref: Ahlstrom 1974, Ahlstrom et al. 1984c.

**Table 15**

**Development of photophores in *Danaphos oculatus* (Ahlstrom et al. 1984c).* See Table 9 for definitions of photophore groups.**

| Size (mm SL) | Photophore groups | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | ORB | OP | SO | BR | IP | PV | VAV | AC | OA |
| Adult | 1 | 3 | 0 | (6) | (3)+(4) | (11) | (5) | (3)+16+(4)+1 | 6 |
| 16.5 | 0 | 0 | 0 | (2) | 0 | 0 | 0 | 0 | 0 |
| 16.5 | 0 | 0 | 0 | (3) | 0 | (3) | 0 | 0 | 0 |
| 19.2 | 0 | 0 | 0 | (4) | 0 | (10) | 0 | 0 | 0 |
| 21.0 | 1 | 1 | 0 | (5) | (2)+(4) | (10/11) | 0 | (2)+0+0+0 | 0 |
| 21.3 | 1 | 1 | 0 | (4/5) | (3)+(4) | (10) | 0 | (3)+0+(2)+0 | 0 |
| 21.8 | 1 | 2 | 0 | (5) | (3)+(4) | (11) | (2) | (3)+8+(4)+0 | 2 |
| 24.2 | 1 | 2 | 0 | (6) | (3)+(4) | (11) | (2) | (3)+9+(4)+0 | 2 |

*Parenthetical numbers indicate photophores found in common glands; nonparenthetical numbers indicate photophores are single.

A

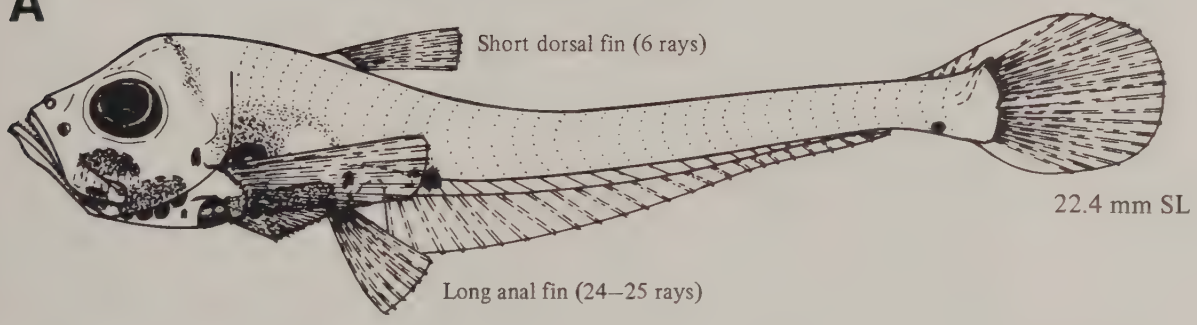



Figure A, NWAFC original (B. Vinter).

## Table 16

**Meristic characters of stomioid genera. Most frequent count or range is followed by overall range or infrequent count in parentheses (Kawaguchi and Moser 1984, in part).**

| Taxon | Vertebrae | Fin rays | | | |
|---|---|---|---|---|---|
| | | Dorsal | Anal | Pectoral | Pelvic |
| Chauliodontidae | | | | | |
| *Chauliodus* | 51-62 | 6,7 (5-7) | 10-12(10-13) | 12,13(11-14) | 7(6-8) |
| Melanostomiidae | | | | | |
| *Bathophilus* | 38-45(33-50) | 13-16 (9-18) | 15-16 (9-18) | 1-37 | 11-16(4-26) |
| *Eustomias* | 56-69 | 21-25(20-30) | 32-46 | 0-13 | 7(6-8) |
| *Opostomias* | 60 | 21 | 24 | 1+4 | 8 |
| *Tactostoma* | 80-82 | 14-16 | 19-22 | 0 | 8-10 |
| Malacosteidae | | | | | |
| *Aristostomias* | 44-56 | 18-26 | 24-32 | 6-10 (3-17) | 6 |
| Idiacanthidae | | | | | |
| *Idiacanthus* | 79-85 | 54-74 | 34(33-39) | 0 | 6 |

## Table 17

**Photophore counts of stomioid genera. Most frequent count or range is followed by overall range or infrequent count in parentheses (Kawaguchi and Moser 1984, in part). Photophore groups as defined by Ahlstrom et al. (1984c) (see Table 9).**

| Taxon | Photophore groups | | | | | |
|---|---|---|---|---|---|---|
| | IP | PV | VAV | AC | OV | VA |
| Chauliodontidae | | | | | | |
| *Chauliodus* | 8-11 | 17-23 | 22-30 | 8-13 | 17-21 | 22-29 |
| Melanostomiidae | | | | | | |
| *Bathophilus* | 5(4-6) | 12-18 | 11-13(11-17) | 5-7 (5-9) | 13-14(10-16) | 9-11 (8-17) |
| *Eustomias* | 7-8(9) | 27-33(24-36) | 13-17(11-21) | 17-23(15-25) | 26-33(24-37) | 13-18(12-22) |
| *Opostomias* | 4+4 | 27 | 17 | 16 | 27 | 17 |
| *Tactostoma* | 8 | 46 | 19 | 12 | 43 | 18 |
| Malacosteidae | | | | | | |
| *Aristostomias* | 5+3 | 15-17(14-19) | 15-18 | 9-11(12) | 16-19(14-20) | 15-17(14-18) |
| Idiacanthidae | | | | | | |
| *Idiacanthus* | IP+PV=31-36 | | 16-18(15) | 13-18 | 22-25 | 31-35(30-36) |

## Table 18

**Pigment characters and gut structure (NT = not trailing, T = trailing freely) in larvae and transforming specimens of stomioids (Kawaguchi and Moser 1984, in part).**

| Taxon | Length of larvae (mm) | Length of transforming specimens (mm) | Dorsal myomere melanophores (*n*/myomere) | Epaxial myoseptum melanophores (*n*/myoseptum) | Hypaxial myoseptum melanophores (*n*/myoseptum) | Gut structure |
|---|---|---|---|---|---|---|
| Chauliodontidae | | | | | | |
| *Chauliodus macouni* | 38-49 | 35-44 | 0 | 0 | 0 | NT* |
| Melanostomiidae | | | | | | |
| *Bathophilus flemingi* | 2.9-23.8 | — | 1 to several | 0 | 0 | NT |
| *Eustomias* sp. | 33 | — | 7 total | 0 | 0 | T |
| *Eustomias* sp. | 13 | — | 7 total | 0 | 0 | T |
| *Eustomias* spp. (4 types) | 6-45 | — | 5-11 total | 0 | 0 | T |
| *Opostomias mitsuii* | 15-21 | — | 1 | 0-1 (2-3 posteriorly) | 1-2 (3-5 posteriorly) | NT |
| *Tactostoma macropus* | 5-44 | 49 | 0-1 | 0 | 1-3 | NT |
| Malacosteidae | | | | | | |
| *Aristostomias scintillans* | 43-47 | 45 | 14 total | 0 | 0 | T |
| Idiacanthidae | | | | | | |
| *Idiacanthus antrostomus* | 4.5-71 | 67> | 0 | 0 | 1 | T |

*Trails slightly.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 56-60-62 |
| | Precaudal: 56-56-56 |
| | Caudal: 4-4-4 |
| **Branchiostegal rays** | 16-X-21 |
| **Caudal fin** | X, 10+9, X |
| **Pelvic fin** | Abdominal |
| | R: 6-7-8 |
| **Dorsal fin** | R: 5-6-7 |
| **Pectoral fin** | R: 10-X-13 |
| **Anal fin** | R: 10-X-13 |
| **Gill rakers** | U: 3-3-3 L: 8-8-8 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Bering Sea, 54-66°N |
| **Ecology** | Epi-, meso-, and bathypelagic, 76-4231 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | >8 yr[a] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 2.69-3.17 mm |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | Segmented |
| **Envelope** | Smooth, clear |
| **Hatch size** | 6-7 mm SL |
| **Incubation time/temp.** | |

**Pigment**

- Pigment in caudal region of yolksac larvae, but soon disappears

**Diagnostic characters**

- Wide perivitelline space, 0.5 mm
- Yolk segmented
- Large egg size

### LARVAE

| | |
|---|---|
| **Preanal length** | Long, >75% SL |
| **Length at flexion** | >15 mm SL |
| **Length at transformation** | Adult ~35-46 mm SL[b] |
| **Sequence of fin development** | Dorsal, anal, and pelvics form late in postflexion larvae in adult position |

**Pigment**

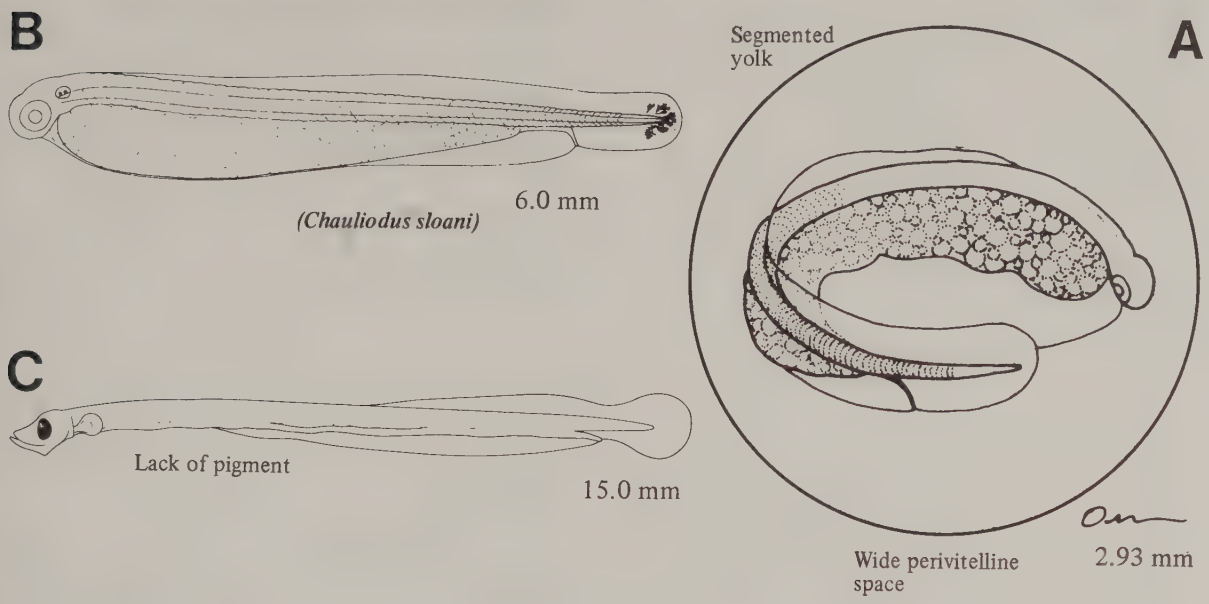
- According to Kawaguchi and Moser (1984), unpigmented except for fan-shaped caudal finfold in yolksac larvae. We have not collected any yolksac larvae and therefore have not observed this pigment. A figure of a yolksac *C. sloani* is included for comparison only.

**Diagnostic characters**

- Morphology: Small head, elliptical eyes, long gut, slender body
- Median finfold shape
- Lack of pigmentation
- Slightly trailing gut

[a] Fitch and Lavenberg 1968
[b] Marked shrinkage at transformation.

Ref: Kawaguchi and Moser 1984.



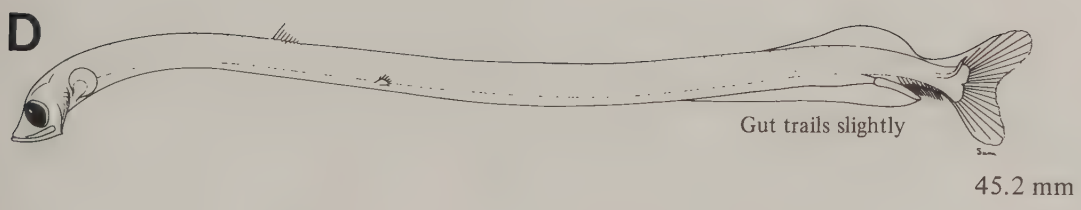




Figure A, Matarese and Sandknop 1984; B, Mito 1961 (western Pacific specimen); C–D, Kawaguchi and Moser 1984.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 44-46-48 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 10-10-10 |
| **Caudal fin** | X, 10+9, X |
| **Pelvic fin** | Abdominal |
| | R: 15-15-17 |
| **Dorsal fin** | R: 15-15-16 |
| **Pectoral fin** | R: 4-5-7, jugular |
| **Anal fin** | R: 16-17-17 |
| **Gill rakers** | U: X-X-X L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Brit. Col., 48°30′-55°N |
| **Ecology** | Meso- and bathypelagic |
| **ELH pattern** | Parity and eggs unknown, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | >75% SL |
| **Length at flexion** | |
| **Length at transformation** | ≤25 mm SL |
| **Sequence of fin development** | Dorsal, anal, and caudal before pectorals and pelvics |

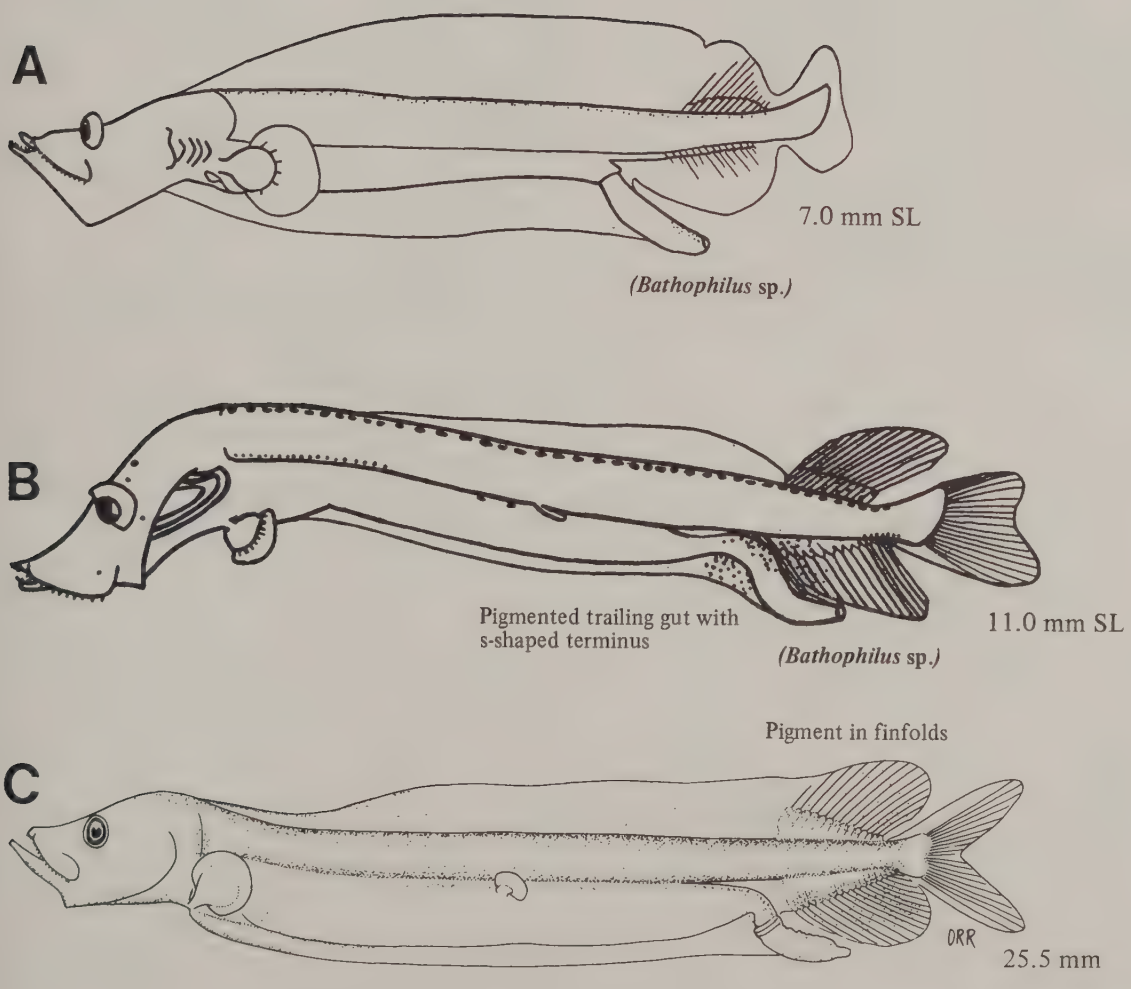
**Pigment**

- One to several melanophores per myomere along dorsum with opposing series along ventral surface
- Head, finfolds, median fins
- Anterodorsal surface of gut and on hindgut
- Pigment more concentrated in larger specimens

**Diagnostic characters**

- Deep bodied
- Large head, jaws
- Gut large (highly developed trailing s-shaped terminus)
- No midlateral pigment
- Large pigmented median finfolds
- Origin of dorsal and anal fin opposite each other

Ref: Kawaguchi and Moser 1984, Ozawa and Aono 1986.




Figures A–B, Beebe and Crane 1939 (North Atlantic specimens); C, Kawaguchi and Moser 1984.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 72-X-78 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | X-X-X | |
| **Caudal fin** | X, 10+9, X | |
| **Pelvic fin** | Abdominal? | |
| | R: 6-X-8 | |
| **Dorsal fin** | R: 20-X-30 | |
| **Pectoral fin** | R: 0-X-13 | |
| **Anal fin** | R: 32-X-46 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Oregon, 42-46°N |
| **Ecology** | |
| **ELH pattern** | Parity and eggs unknown, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE - Genus

| | |
|---|---|
| **Preanal length** | >75% SL (trailing gut) |
| **Length at flexion** | |
| **Length at transformation** | ~45 mm SL |
| **Sequence of fin development** | |

**Pigment**

- 5-11 large melanophores along dorsal midline
- Lower jaw symphysis

**Diagnostic characters**

- Morphology: Slender body, head elongate and flat
- Gut: Long, slender, deflected ventrad at anal fin origin, trailing from body
- Dorsal pigment patches
- Origin of dorsal fin behind that of anal fin

Distinguished from *Aristostomias scintillans* (p. 118) by

- Unpigmented gut
- Lack of ventral body pigment
- <20 dorsal spots (5-11)

[a] Possibly 1-4 species in the area, although only one larval form has been collected.

Ref: Kawaguchi and Moser 1984, Ozawa and Aono 1986.

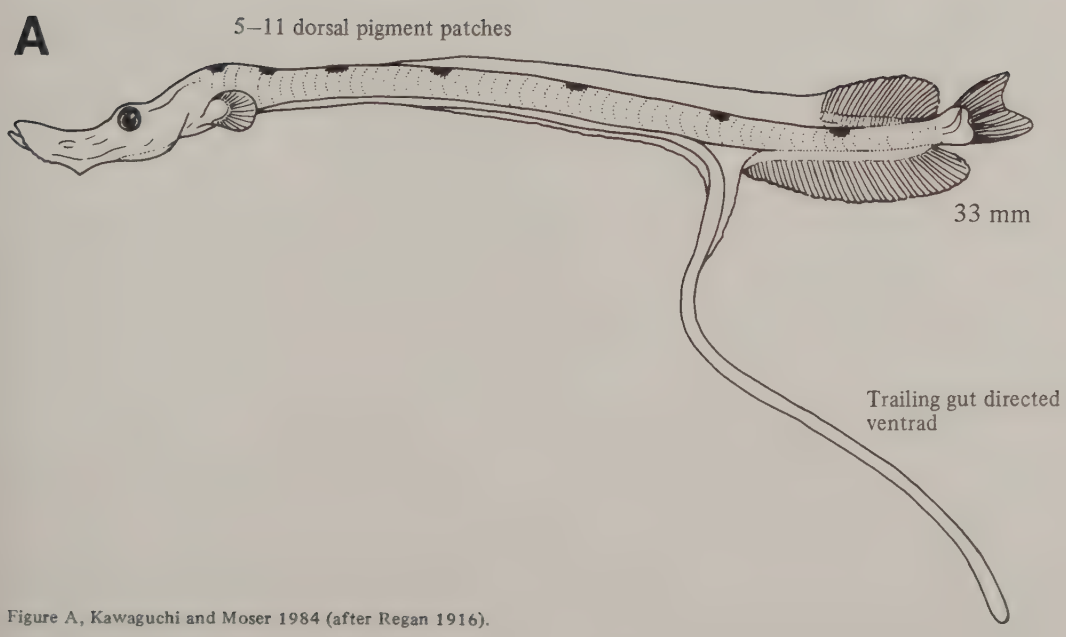



Figure A, Kawaguchi and Moser 1984 (after Regan 1916).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: X-X-X |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 10-X-15 |
| **Caudal fin** | X, 10+9, X |
| **Pelvic fin** | Abdominal |
| | R: 7-X-8 |
| **Dorsal fin** | R: 21-X-23 |
| **Pectoral fin** | R: 5-5-5 |
| **Anal fin** | R: 21-X-24 |
| **Gill rakers** | U: 2-2-2 L: 8-8-8 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Brit. Col., 48°30′-55°N |
| **Ecology** | Epi- and mesopelagic |
| **ELH pattern** | Parity and eggs unknown, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

**Preanal length**
**Length at flexion**
**Length at transformation**
**Sequence of fin development** Caudal, dorsal, and anal before pectorals and pelvics
**Pigment**

- One expanded melanophore per myomere along dorsum
- 1-2 melanophores on each hypaxial myoseptum
- Area under dorsal fin appears banded
- Dorsally on head
- Gill arch
- Gut terminus

**Diagnostic characters**

- Morphology
  - —Moderately deep body
  - —Large mouth
  - —Large finfold
  - —Elongate sloping snout
  - —Eyes small
  - —No trailing gut
- Pigment pattern
- Origin of dorsal fin slightly before that of anal fin
- 13-15 myomeres between pelvic and anal fins

Ref: Kawaguchi and Moser 1984, Ozawa and Aono 1986.

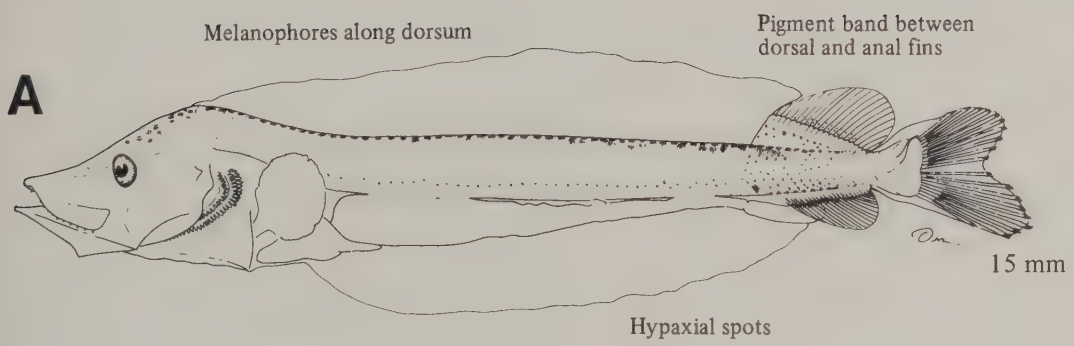



Figure A, Kawaguchi and Moser 1984 (western Pacific specimen).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 80-X-82 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 13-13-13 |
| **Caudal fin** | X, 10+9, X |
| **Pelvic fin** | Abdominal |
| | R: 8-9-10 |
| **Dorsal fin** | R: 14-X-17 |
| **Pectoral fin** | Absent in adults |
| **Anal fin** | R: 19-19-22 |
| **Gill rakers** | U: X-X-X L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Bering Sea, 54-66°N |
| **Ecology** | Epi- and mesopelagic, 31-549 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Summer (Oregon)[a] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: 24,000-66,000 (one spawn/year)[a] |
| **Age at first maturity** | 6 yr (females)[a] |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.39-1.54 mm |
| **No. of oil globules** | One |
| **Oil globule diameter** | 0.3-0.4 mm |
| **Yolk** | Segmented |
| **Envelope** | Smooth |
| **Hatch size** | 5 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

- Oil globule large and ventral
- Egg round

### LARVAE

| | |
|---|---|
| **Preanal length** | >75% SL |
| **Length at flexion** | |
| **Length at transformation** | 44-49 mm SL |
| **Sequence of fin development** | Caudal, dorsal and anal, pectorals and pelvics |

**Pigment**

- In early larvae, one melanophore per myomere along dorsum and 1-3 melanophores on hypaxial myosepta; postflexion larvae gradually lose the dorsal then ventral melanophores
- Lower jaw, isthmus, pectoral fin base, cleithrum, gut terminus, caudal peduncle

**Diagnostic characters**

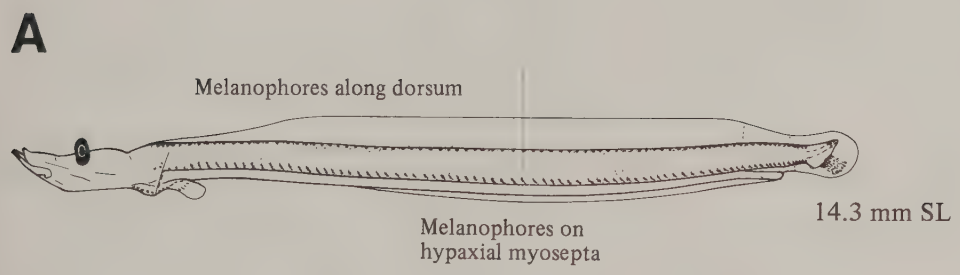
- Morphology: Body elongate and flat, gut slender, finfold moderate
- Pectoral fin lost at transformation
- Decrease in pigment with development
- No trailing gut
- Finfolds unpigmented

Distinguished from *Chauliodus macouni* (p. 108) by

- Presence of pigment
- Posterior position of dorsal fin (origin of dorsal and anal fin opposite each other)

[a] Fisher and Pearcy 1983

Ref: Kawaguchi and Moser 1984, Ozawa and Aono 1986.



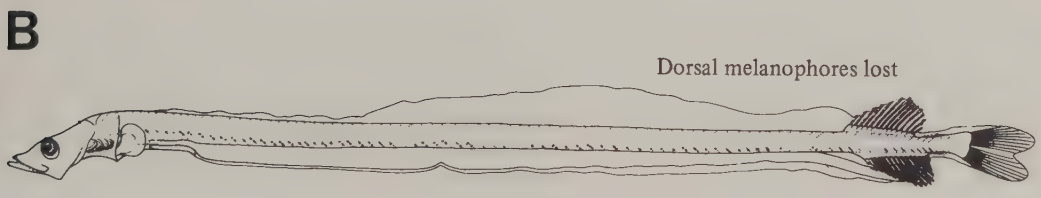




Figure A, NWAFC original (B. Vinter); B, Kawaguchi and Moser 1984.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 54-54-54 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 8-8-8 | |
| **Caudal fin** | X, 10+9, X | |
| **Pelvic fin** | Abdominal | |
| | R: 6-X-7 | |
| **Dorsal fin** | R: 21-X-23 | |
| **Pectoral fin** | R: 4-X-8 | |
| **Anal fin** | R: 25-X-29 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Bering Sea, 54-66°N |
| **Ecology** | Epi- and mesopelagic |
| **ELH pattern** | Parity and eggs unknown, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | |
| **Length at flexion** | |
| **Length at transformation** | 45 mm SL |
| **Sequence of fin development** | Dorsal, anal, and caudal; pectorals, pelvics |

**Pigment**

- Series of paired melanophores along dorsum; initially 14 pairs which increase in number with development
- Paired ventral series develops initially posteriorly and increases in number with development
- Brain, snout, lower jaw, otic region, gular-isthmus region, caudal fin, gut

**Diagnostic characters**

- Morphology: Body and gut slender, trailing gut, large flat head, finfold moderate

Distinguished from *Eustomias* spp. (p. 112) by

- Pigment on trailing gut
- Pigment along ventral midline

Ref: Kawaguchi and Moser 1984.

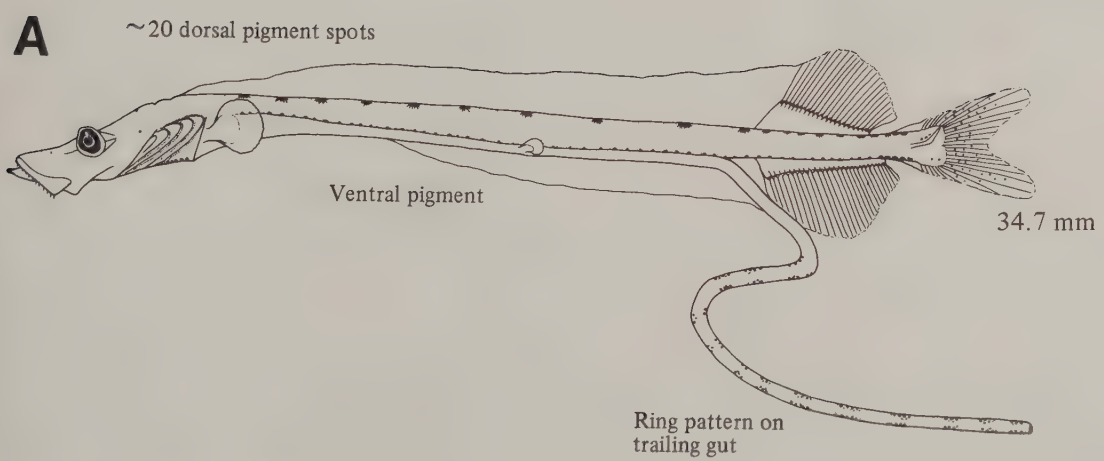



Figure A, Kawaguchi and Moser 1984.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 81-X-83 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 12-X-18 |
| **Caudal fin** | X, 10+9, X |
| **Pelvic fin**[a] | Abdominal |
| | R: 6-6-6 |
| **Dorsal fin** | R: 54-X-66 |
| **Pectoral fin** | Absent in adults |
| **Anal fin** | R: 28-X-43 |
| **Gill rakers** | U: X-X-X L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to N. California, 38-42°N |
| **Ecology** | Meso- and bathypelagic |
| **ELH pattern** | Parity and eggs unknown, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: 14,000[a] |
| **Age at first maturity** | |
| **Longevity** | >6 yr (females)[a] |
| | <1 yr (males)[a] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | |
| **Length at flexion** | |
| **Length at transformation** | 35-70 mm SL |
| **Sequence of fin development** | Caudal, dorsal and anal, pectorals,[b] pelvics[c] |

**Pigment** - Genus
- Melanophore on posterior margin of each hypaxial myomere
- Isthmus
- Series along trailing gut

**Diagnostic characters** - Genus
- Morphology
  - —Extremely slender body
  - —Elongate flat head
  - —Elliptical eyes on stalks with cartilaginous support rods (27% BL)
  - —Trailing gut
  - —Small finfold

Distinguished from *I. fasciola* by
- Longer eye stalk and trailing gut

Since specimens are often damaged and pigment patterns are similar, the two species may be difficult to separate. In addition to the above characters, the two species differ in size at various stages of development. *I. antrostomus* larvae are 4.5-71.0 mm SL, transforming at sizes >67 mm SL. *I. fasciola* larvae are 16-28 mm SL, transforming at sizes between 35 and 48 mm SL.

[a] Fitch and Lavenberg 1968
[b] Pectoral fins lost at transformation.
[c] Pelvic fins develop in transforming females.

Ref: Kawaguchi and Moser 1984.

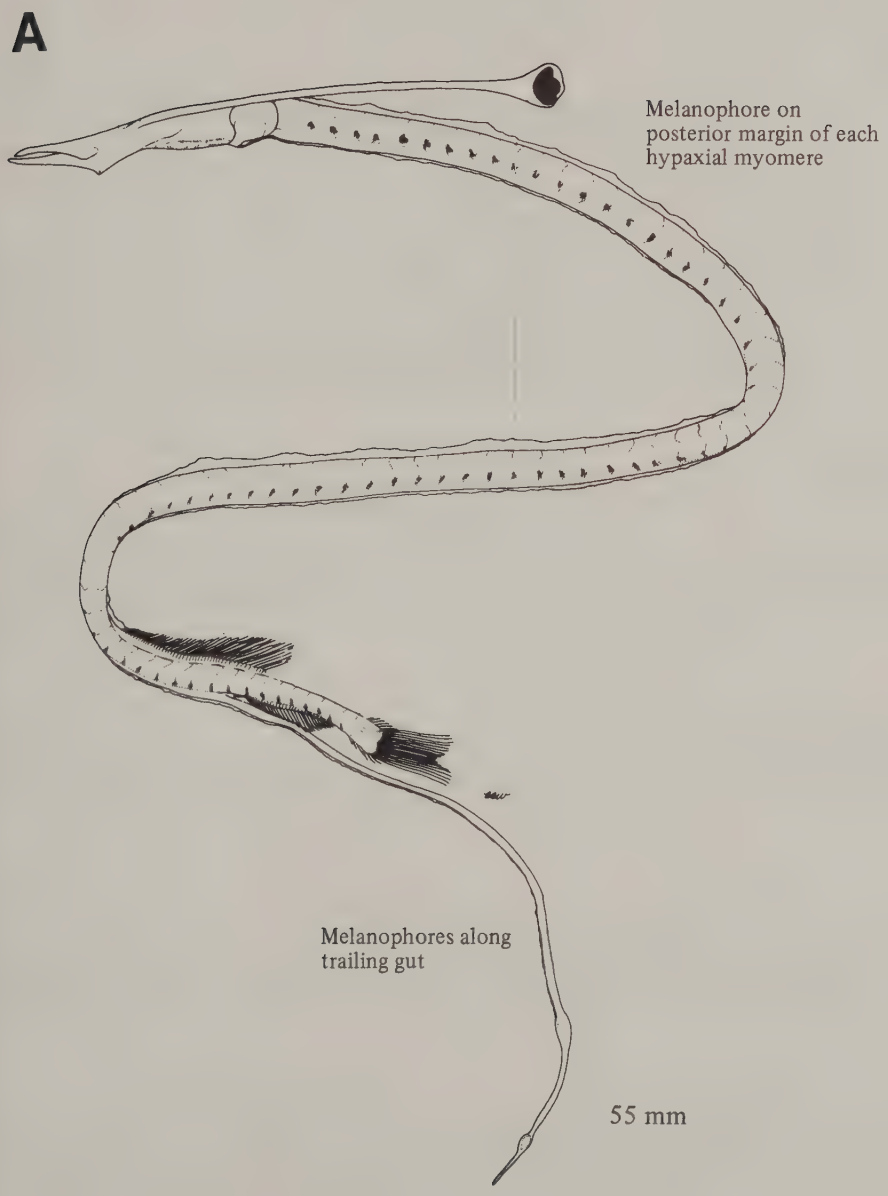



Figure A, Kawaguchi and Moser 1984.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: X-X-X |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 12-X-18 |
| **Caudal fin** | X, 10+9, X |
| **Pelvic fin** | Abdominal |
| | R: 6-6-6 |
| **Dorsal fin** | R: 56-X-77 |
| **Pectoral fin** | Absent in adults |
| **Anal fin** | R: 38-X-54 |
| **Gill rakers** | U: X-X-X L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Oregon, 42-46°N |
| **Ecology** | Meso- and bathypelagic |
| **ELH pattern** | Parity and eggs unknown, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

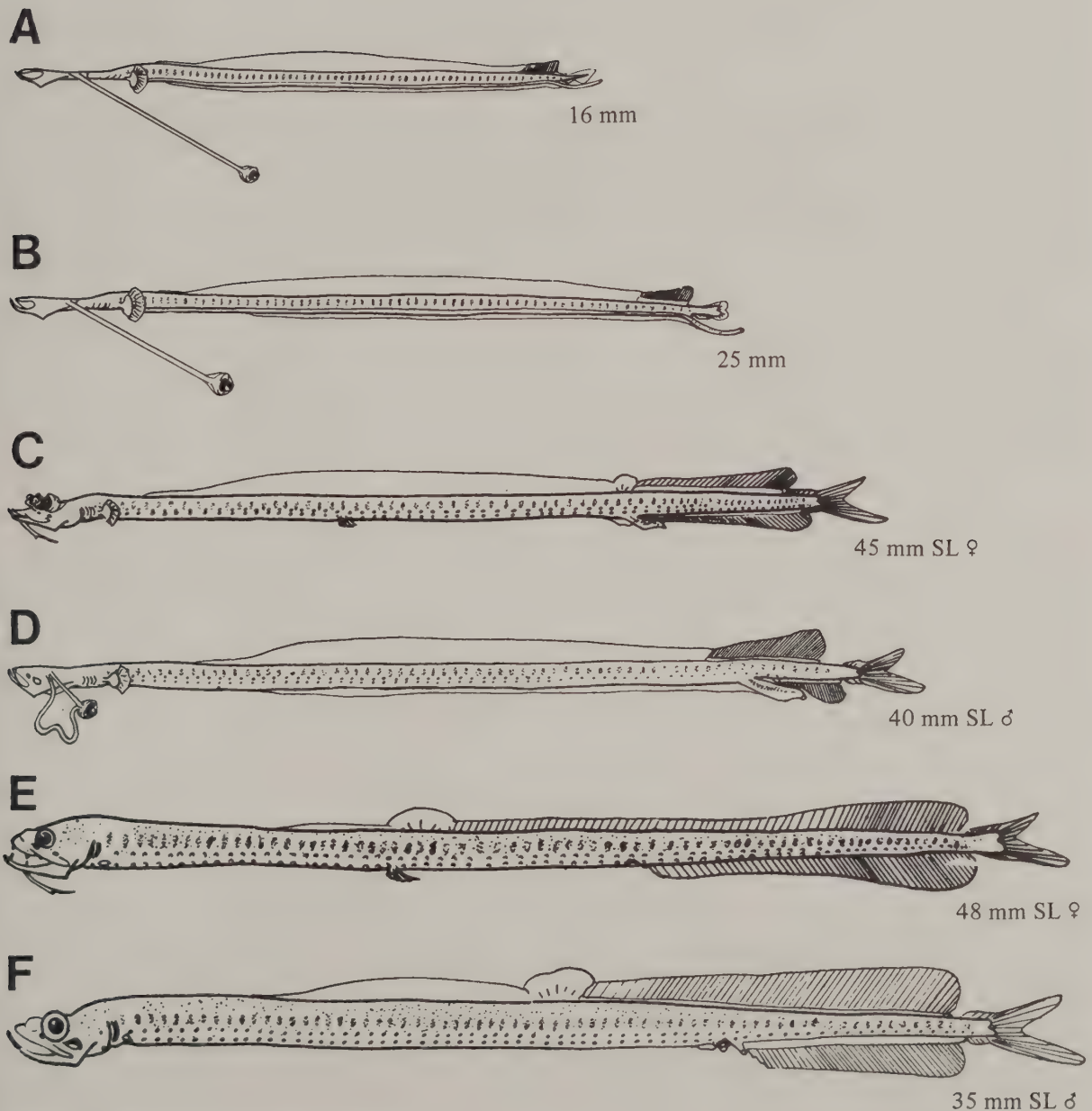
**Preanal length**
**Length at flexion**
**Length at transformation** 32-42 mm SL (males)
**Sequence of fin development**
**Pigment**

- See *I. antrostomus* (p. 120)

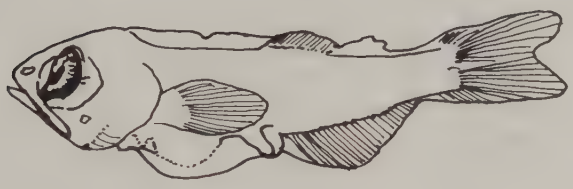
**Diagnostic characters**

- See *I. antrostomus*
- Depending on length of larvae, length of trailing gut may differ

Ref: Kawaguchi and Moser 1984.




Figures A–F, Beebe 1934 (North Atlantic specimens).



## Scopelomorpha: Aulopiformes
## Myctophiformes

The myctophiforms (Myctophidae and Neoscopelidae) and aulopiforms (J. Nelson 1984) are treated together here. According to J. Nelson (1984), these orders consist of 14 families, and about 75 genera with 429 species. Although several families are benthic (e.g., synodontids), most families consist of deep-sea, pelagic, and benthopelagic forms. Many families (not myctophids) are synchronous hermaphrodites. The diverse early-life-history stages are generally well known and can be distinguished by morphological characters (head, gut, body) and pigment patterns. Additionally, photophore patterns and development are especially helpful in myctophid fishes, while gut pigment (i.e., number and development of peritoneal patches) is an important character distinguishing some of the other families.

Families in study area: **Scopelarchidae**
**Notosudidae**
**Synodontidae**
**Bathysauridae**
**Paralepididae**
**Anotopteridae**
**Alepisauridae**
**Neoscopelidae**
**Myctophidae**

## MERISTICS *B. dentata* (Chapman 1939)

| | |
|---|---|
| **Vertebrae** | Total: 54-54-55 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 8-8-8 |
| **Caudal fin** | X, 10+9, X |
| **Pelvic fin** | Abdominal |
| | R: 9-9-9 |
| **Dorsal fin** | R: 6-7-8 |
| **Pectoral fin** | R: 21-24-25 |
| **Anal fin** | R: 17-19-21 |

## MERISTICS *B. linguidens* (Mead and Böhlke 1953)

| | |
|---|---|
| **Vertebrae** | Total: 64-64-64 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | X-X-X |
| **Caudal fin** | X, 10+9, X |
| **Pelvic fin** | Abdominal |
| **Dorsal fin** | R: 8-X-9 |
| **Pectoral fin** | R: 24-X-25 |
| **Anal fin** | R: 28-X-30 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Bering Sea, 54-66°N[a] |
| **Ecology** | Mesopelagic, 200-1000 m[b] |
| **ELH pattern** | Oviparous, eggs unknown, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: Synchronous hermaphrodites[c] |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE[b]

| | |
|---|---|
| **Preanal length** | Anus moves posteriad during transformation |
| **Length at flexion** | |
| **Length at transformation** | 50 mm SL[d] |
| **Sequence of fin development** | Caudal; dorsal, anal, and dorsal part of pectoral; pelvics; ventral part of pectoral |

**Pigment**

- No "accessory" pigment
- No "dermal" pigment; develops in transforming larvae and persists in adults

**Diagnostic characters**

- Gut expansion (in larvae, anus anterior to pelvic fin base but moves posteriad during transformation)
- Pelvic fin origin ahead of dorsal fin origin
- Adipose fin develops posterior to anal fin
- No peritoneal pigment in larvae

[a] *B. linguidens* only to Oregon, 42-46° N.
[b] *B. dentata* only, *B. linguidens* larvae are incompletely known.
[c] Johnson 1974a
[d] Larvae of *Benthalbella* spp. are unique among scopelarchids in achieving a large size (50-100 mm SL) while retaining a purely larval form and then exhibiting a very rapid transformation. The largest known larvae of *B. linguidens* = 85.5 mm SL, and may transform at larger sizes than *B. dentata*. Transformation is complete when peritoneal pigment first appears (uniformly in mesentary dorsal to gut from between pectoral fin bases to behind pelvic fins).

Ref: R.K. Johnson 1984.

*B. linguidens*

49.0 mm SL

*B. dentata*

42.8 mm SL

53.0 mm SL

Figures A–C, Johnson 1974a.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 58-X-61 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 10-10-10 | |
| **Caudal fin** | X, 10+9, X | |
| **Pelvic fin** | Abdominal | |
| | R: 9-X-10 | |
| **Dorsal fin** | R: 10-X-12 | |
| **Pectoral fin** | R: 10-X-14 | |
| **Anal fin** | R: 16-X-19 | |
| **Gill rakers** | U: 2-2-2 | L: 17-X-19 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Aleutian Is., 51-55°N |
| **Ecology** | Mesopelagic, 500-800 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season:<br>Area:<br>Mode: Synchronous hermaphrodites[a]<br>Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | Probably small |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | |
| **Length at transformation** | 25-45 mm SL |
| **Sequence of fin development** | Caudal, anal, dorsal, pectorals, pelvics (family) |

**Pigment**

- Restricted to tail along hypural region

**Diagnostic characters**—Family

- Hypural pigment: Exact distribution of pigment on the hypural region is diagnostic for species within the family
- Long body, becoming compressed toward tail
- Depressed head
- Posteriorly protruding lobes in brain (corpus cerebelli)
- Conical mass of choroid tissue around narrowed eye; long axis of the narrow eye is horizontal rather than vertical or oblique as it is in most other narrow-eyed larvae
- Anus at midbody; widely separated from anal fin
- Maxillary teeth

[a] Okiyama 1984

Ref: Okiyama 1984, Ozawa 1978.

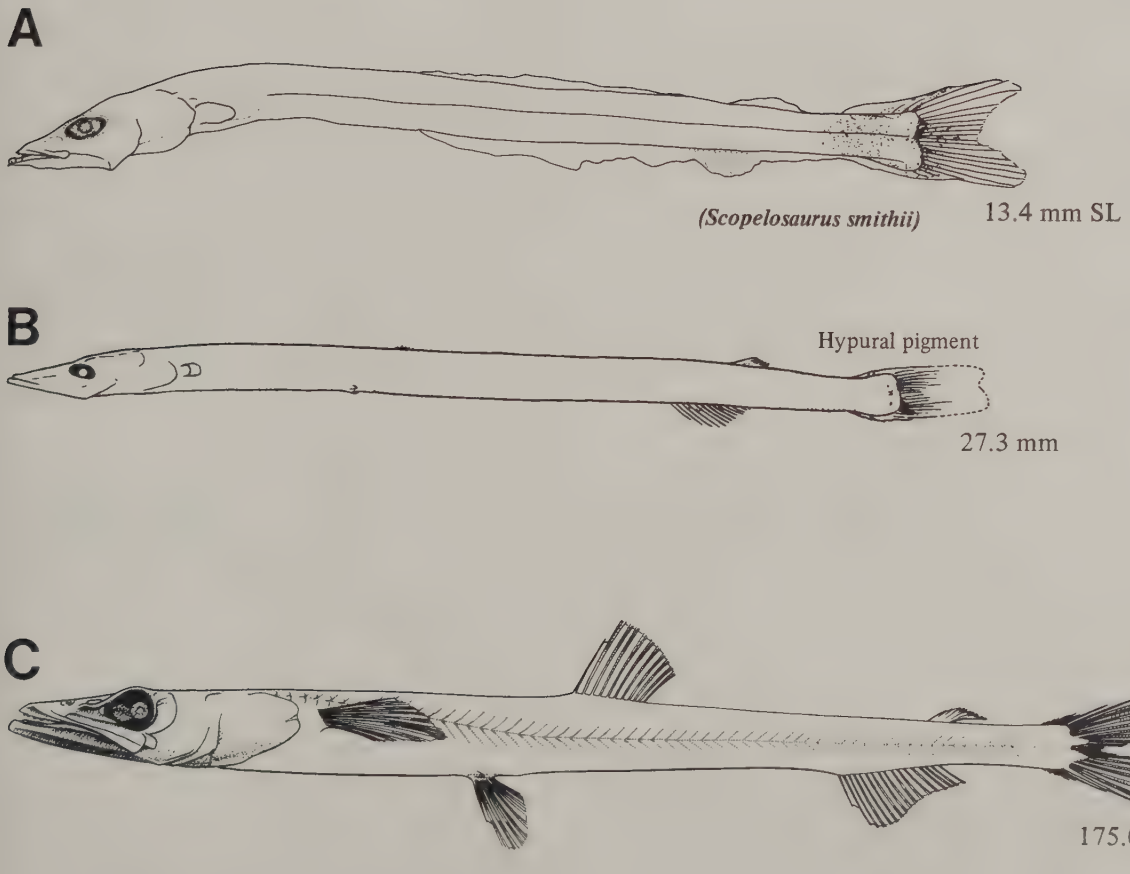



Figure A, Okiyama 1984 (southwestern Pacific specimen); B–C, Bertelsen et al. 1976 (North Atlantic specimens).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 50-X-52 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 8-8-8 |
| **Caudal fin** | 7, 10+9, 6 |
| **Pelvic fin** | Abdominal |
| | R: 8-8-8 |
| **Dorsal fin** | R: 15-X-17 |
| **Pectoral fin** | R: 16-X-17 |
| **Anal fin** | R: 11-13-13 |
| **Gill rakers** | U: 5-X-6 L: 14-X-16 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Oregon, 42-46°N |
| **Ecology** | Bathybenthal |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: Synchronous hermaphrodites[a] |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | Ovarian eggs of *B. ferox* 1.2 mm[b] |
| **Number of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE[c]

| | |
|---|---|
| **Preanal length** | 70% SL |
| **Length at flexion** | |
| **Length at transformation** | >83 mm SL (gradual)[d] |
| **Sequence of fin development** | |

**Pigment**

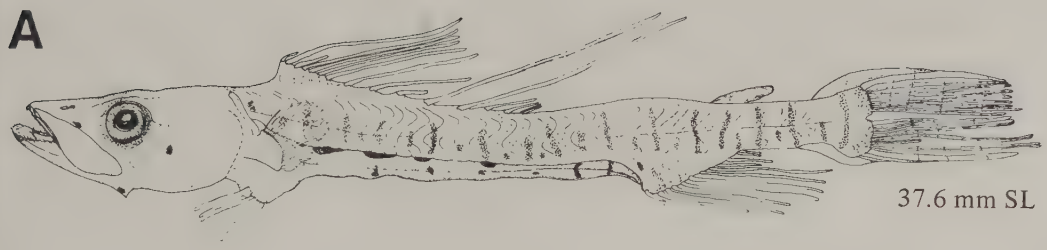
- Peritoneal patches, about five; about six short bars laterally on gut
- About 17 vertical bars along body, 8 shorter bars in interspaces between vertical bars
- Several spots on head and fin rays

**Diagnostic characters**—Family

- Elongate fins
- Anterior placement of dorsal and pelvic fins
- Raised dorsal and anal fin bases
- Long gut terminating in front of anal origin
- Pigment: Peritoneal (5-6 sections) and lateral bars

[a] Okiyama 1984
[b] Wenner 1978
[c] *B. mollis* larvae originally described as "*Macristium*" larvae (Johnson 1974b). An illustration of *B. ferox* is provided for comparison and to show fin rays intact.
[d] Changes at transformation include shortening of fins, expansion of gape, backward shift of dorsal fin origin, and darkening of body surface, oral cavity, and peritoneum. According to Sulak et al. (1985), the large sizes attained by these larvae suggest a long oceanic existence prior to transformation.

Ref: Johnson 1974b, Okiyama 1984, Sulak et al. 1985.



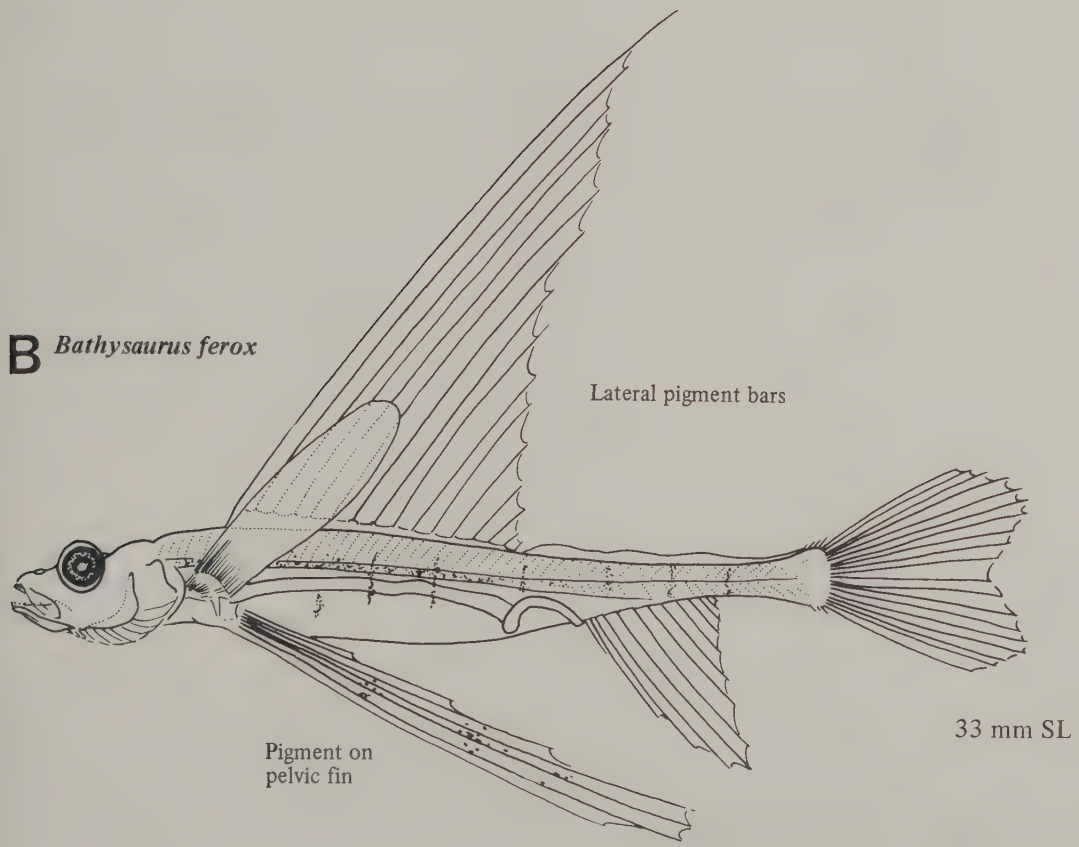




Figure A, Johnson 1974b (Gulf of Mexico specimen); B, Marshall 1960 (Atlantic specimen).

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 60-62-63 | |
| | Precaudal: 49-52-54 | |
| | Caudal: 8-10-11 | |
| **Branchiostegal rays** | 18-18-18 | |
| **Caudal fin** | X, 10+9, X | |
| **Pelvic fin** | Abdominal | |
| | R: 8-8-8 | |
| **Dorsal fin** | R: 11-X-13 | |
| **Pectoral fin** | R: 13-X-14 | |
| **Anal fin** | R: 12-X-14 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to N. California, 38-42°N[a] |
| **Ecology** | Epi- and mesodemersal |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.33-1.44 mm |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | Hexagonal surface |
| **Hatch size** | <4.7 mm SL |
| **Incubation time/temp.** | |

**Pigment**

- Unpigmented until late stage of development when pigment first appears along dorsal midline
- Few scattered yolksac spots
- Late-stage embryo resembles newly hatched larva with distinctive pigment along gut

**Diagnostic characters**

- Hexagonal surface similar to *Pleuronichthys coenosus* (p. 616) except hexagons are wider (0.047 mm vs. 0.035 mm) and irregularly arranged[b]

### LARVAE[c]

| | |
|---|---|
| **Preanal length** | >50% SL |
| **Length at flexion** | ~10.5 mm SL |
| **Length at transformation** | |
| **Sequence of fin development** | Caudal, anal, dorsal, pectorals, pelvics |

**Pigment**

- Seven evenly spaced pairs of "peritoneal patches" which form gradually
- Spot on postanal ventral midline midway between anus and tail
- Spot in area where hypurals are forming

**Diagnostic characters**

- Distinctive peritoneal patches (seven)
- Preanal finfold
- Deeper body than other *Synodus* spp.

[a] During "El Niño" years, adults occur as far north as Puget Sound, Washington. Postflexion larvae were collected off Oregon during the strong El Niño summer of 1982 (B. Mundy, NMFS Southwest Fish. Cent., Honolulu Lab., 2570 Dole St., Honolulu, HI 96822, pers. commun., 1 Oct. 1986).

[b] See Sumida et al. 1979.

[c] Data on preflexion and postflexion larvae are from E.H. Ahlstrom notes. Illustrations are unavailable.

Ref: Okiyama 1974, 1984; Ozawa 1986c; Sumida et al. 1979.

A

Figure A, Okiyama 1984.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 84-X-87 |
| | Precaudal: 41-41-41 |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 8-8-8 |
| **Caudal fin** | 13, 10+9, 13 |
| **Pelvic fin** | Abdominal |
| | R: 8-10-11 |
| **Dorsal fin** | R: 9-12-12 |
| **Pectoral fin** | R: 11-11-12 |
| **Anal fin** | R: 26-26-33 |
| **Gill rakers** | U: 3-X-9 L: 21-X-31 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Brit. Col., 48°30′-55°N |
| **Ecology** | Epi-, meso-, and bathypelagic |
| **ELH pattern** | Oviparous, eggs unknown, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: Synchronous hermaphrodites[a] |
| | Migration |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL, increasing with development |
| **Length at flexion** | |
| **Length at transformation** | ~45 mm SL |
| **Sequence of fin development** | Caudal, anal, dorsal, pectorals, pelvics (family) |

**Pigment**

- Tip of jaw, two dorsal and one ventral midline spot
- Peritoneal patches increase during development to about seven
- With development, head, dorsal and anal fin bases, and caudal peduncle

**Diagnostic characters** - Family

- Pigment, especially peritoneal patches[b]
- Elongation of gut with development
- Morphology[c]

Distinguished from *Notolepis rissoi* and *Paralepis atlantica* by

| | *Lestidiops* | *Notolepis* | *Paralepis* |
|---|---|---|---|
| No. peritoneal patches | | | |
| (flexion larvae) | 3 | 1 | 2 |
| (postflexion larvae) | 7 | 12 | 3 |
| No. myomeres | 84-87 | 72-74 | 76-83 |

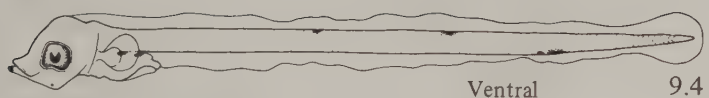
[a] Okiyama 1984

[b] Peritoneal pigment patches are sequentially formed with gradual lengthening of the gut. The number of patches (called "sections" by Okiyama 1984) may be species-specific. In general, these patches develop by 5-10 mm SL and persist until 15-45 mm SL. Other characteristic paralepidid pigment may include dorsum of body, caudal peduncle, and caudal and pectoral fins.

[c] General morphological characters in paralepidids are a long compressed body, short gut increasing in length with development, head increasing in relative size with development, elongate snout, well-developed preanal finfold, and eyes initially ovoid, becoming round with development.

Ref: Okiyama 1984.

A

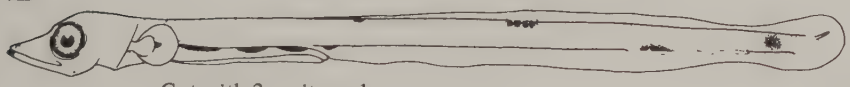


Short gut with 2 peritoneal patches

Ventral pigment

9.4 mm NL

B



Gut with 3 peritoneal patches

16.5 mm NL

C

Dorsal fin base pigment

Pigment above and below notochord along peduncle

Jaw pigment

Elongate gut with 7 peritoneal patches

Anal fin base pigment

28.5 mm SL

Figures A, C, Okiyama 1984; B, Moser 1981.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 72-X-74 | |
| | Precaudal: 37-X-39 | |
| | Caudal: 39-X-41 | |
| **Branchiostegal rays** | 8-8-8 | |
| **Caudal fin** | X, 10+9, X | |
| **Pelvic fin** | Abdominal | |
| | R: 8-X-12 | |
| **Dorsal fin** | R: 9-X-13 | |
| **Pectoral fin** | R: 10-X-13 | |
| **Anal fin** | R: 29-X-34 | |
| **Gill rakers** | U: 3-X-9 | L: 18-X-36 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Brit. Col., 48°30′-55°N |
| **Ecology** | Epi-, meso-, and bathypelagic |
| **ELH pattern** | Oviparous, eggs unknown, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: Synchronous hermaphrodites[a] |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL, increasing with development |
| **Length at flexion** | ~13-18 mm SL |
| **Length at transformation** | ~45 mm SL |
| **Sequence of fin development** | Caudal, anal, dorsal, pectorals, pelvics (family) |

**Pigment**

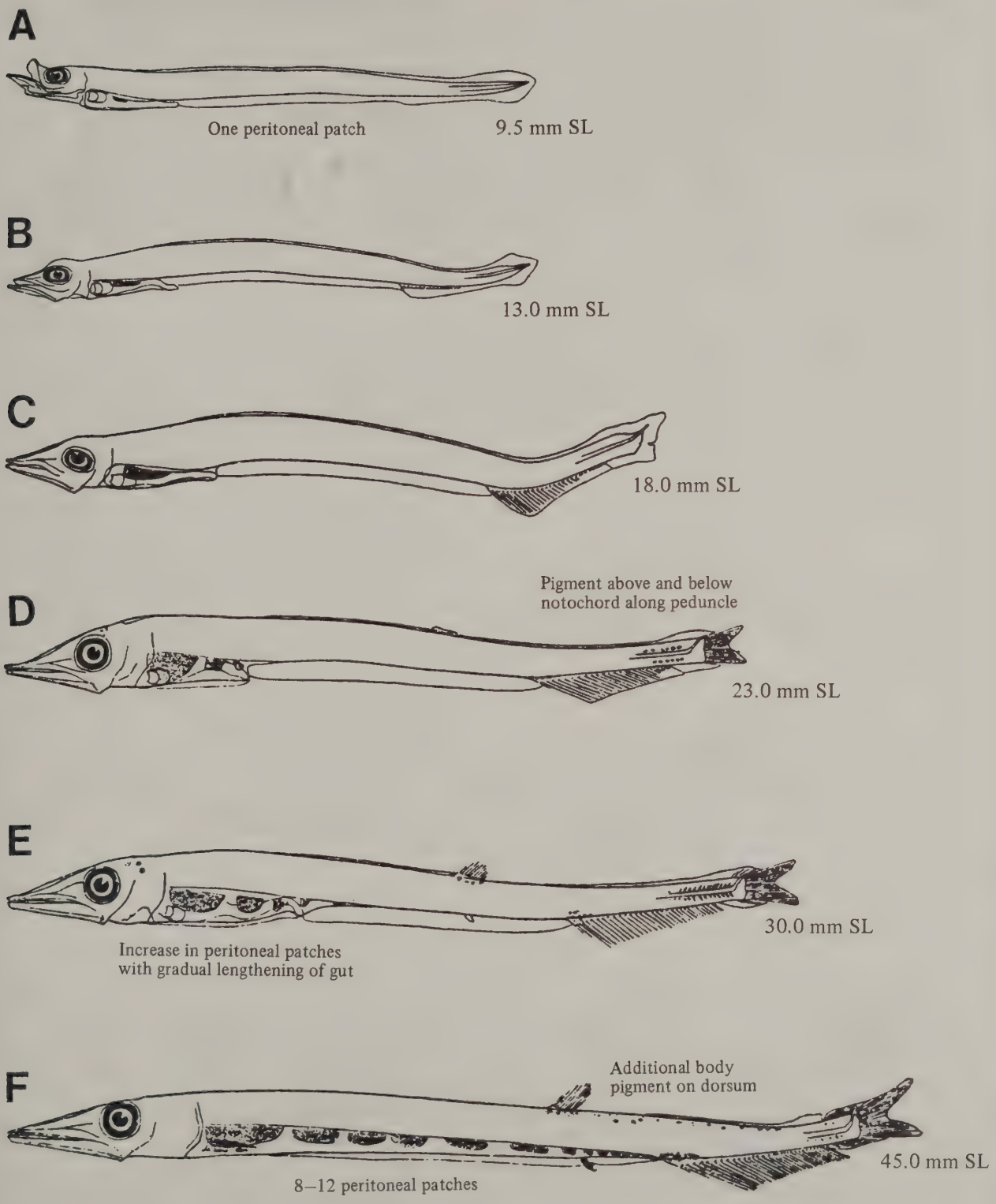
- Peritoneal patches, 1 increasing with development to 12 (see *Lestidiops ringens*)
- Above and below notochord on caudal peduncle
- Additional pigment along dorsum from dorsal fin origin to tail with development

**Diagnostic characters**

- See *L. ringens* (p. 134)
- Pigment, peritoneal patches
- Morphology

[a] Okiyama 1984

Ref: Okiyama 1984.




Figures A–F, Rofen 1966a (North Atlantic specimens).

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 60-67-69 | |
| | Precaudal: 38-40-41 | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 8-8-8 | |
| **Caudal fin** | X, 10+9, X | |
| **Pelvic fin** | Abdominal | |
| | R: 9-X-10 | |
| **Dorsal fin** | R: 9-X-12 | |
| **Pectoral fin** | R: 15-X-18 | |
| **Anal fin** | R: 20-X-23 | |
| **Gill rakers** | U: 7-X-9 | L: 26-X-32 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to SE Alaska, 55-59° N |
| **Ecology** | Epi-, meso-, and bathypelagic |
| **ELH pattern** | Oviparous, eggs unknown, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: Synchronous hermaphrodites[a] |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

**Preanal length**
**Length at flexion**
**Length at transformation**
**Sequence of fin development** Caudal, anal, dorsal, pectorals, pelvics (family)
**Pigment**

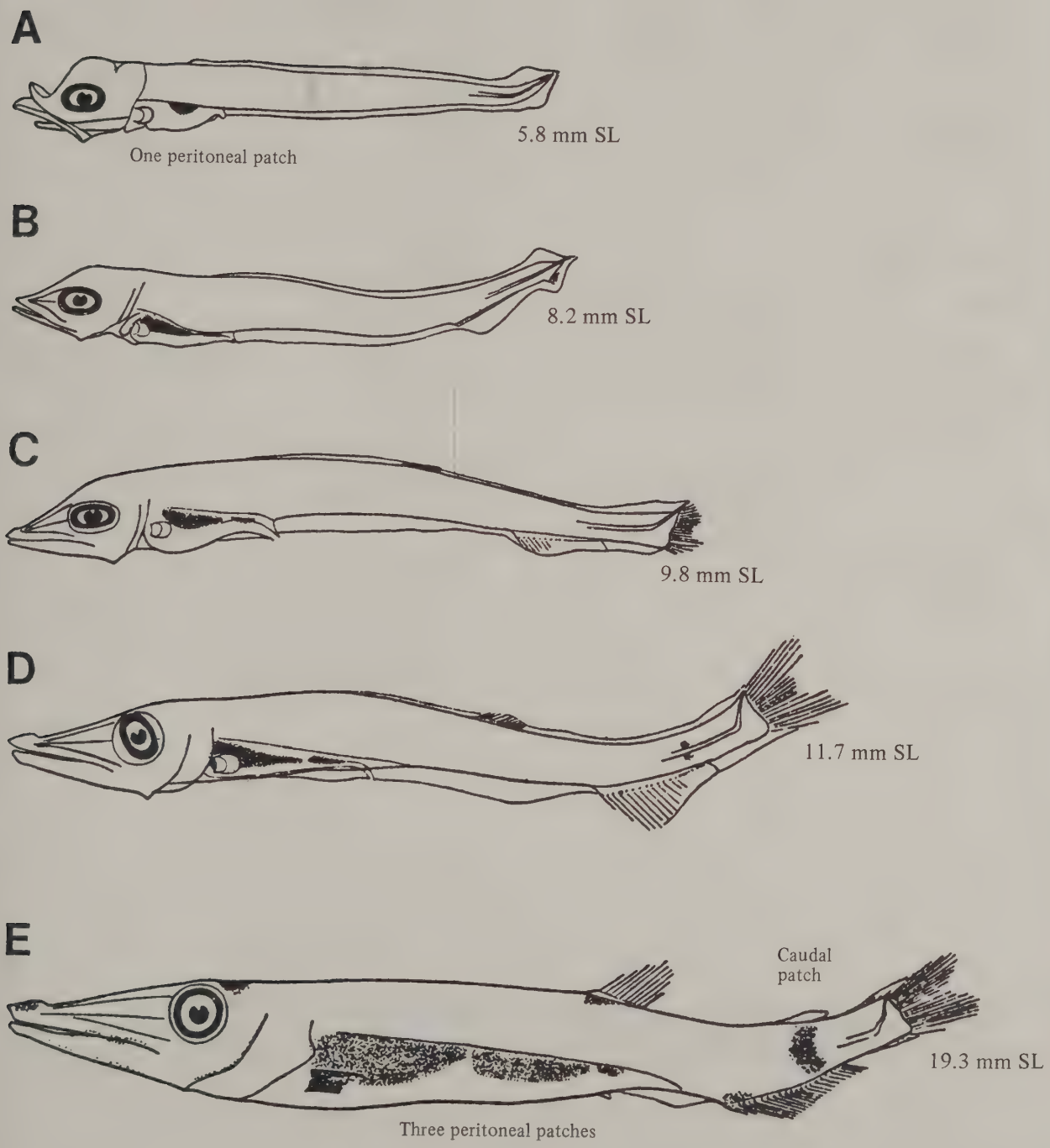
- Peritoneal patches, one increasing with development to three (see *Lestidiops ringens*, p. 134)
- Few spots above and below notochord in caudal peduncle region which, with development, form a patch
- Patch at base of dorsal and anal fin, on cranium, on upper jaw (late in development)

**Diagnostic characters**

- See *L. ringens*
- Pigment, peritoneal patches
- Morphology

[a] Okiyama 1984

Ref: Okiyama 1984.




Figures A–E, Rofen 1966a (North Atlantic specimens).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 76-80-83 |
| | Precaudal: 48-52-54 |
| | Caudal: 27-29-31 |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | 14-15, 10+9, 14 |
| **Pelvic fin** | Abdominal |
| | R: 9-X-11 |
| **Dorsal fin** | Absent |
| **Pectoral fin** | R: 12-X-16 |
| **Anal fin** | R: 14-X-17 |
| **Gill rakers** | U: X-X-X L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Bering Sea, 54-66°N |
| **Ecology** | Epi- and mesopelagic |
| **ELH pattern** | Oviparous, eggs unknown, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: Synchronous hermaphrodites[a] |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE[b]

| | |
|---|---|
| **Preanal length** | >50% SL |
| **Length at flexion** | |
| **Length at transformation** | <50 mm SL |
| **Sequence of fin development** | Only pectoral anlagen present at 14.2 mm SL |

**Pigment**

- No peritoneal pigment patches, instead uniform peritoneal pigment
- Snout, jaw
- Dorsal midline
- Tail tip

**Diagnostic characters**

- Morphology: Long slender body, large head, pointed snout
- Fleshy prolongation at jaw tips
- Two large canine teeth
- Gut extending to midbody

[a] Okiyama 1984
[b] Data are from one larva.

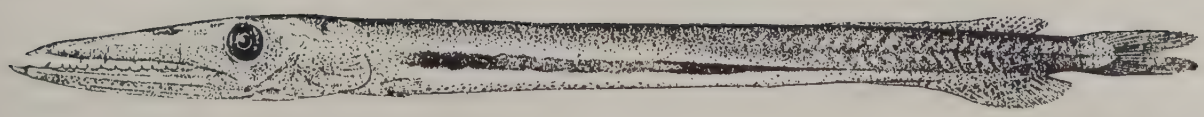
Ref: Okiyama 1984.

A

Fleshy prolongation of jaws

14.2 mm SL

B



50.0 mm SL

Figure A, Okiyama 1984; B, Rofen 1966b (North Atlantic specimen).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 48-50-52 |
| | Precaudal: 19-23-26 |
| | Caudal: 24-27-31 |
| **Branchiostegal rays** | 8-8-8 |
| **Caudal fin** | X, 10+9, X |
| **Pelvic fin** | Abdominal |
| | R: 8-X-10 |
| **Dorsal fin** | R: 30-X-45 |
| **Pectoral fin** | R: 12-X-15 |
| **Anal fin** | R: 14-X-17 |
| **Gill rakers** | U: 2-X-6 L: 16-X-24 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Bering Sea, 54-66°N |
| **Ecology** | Epi-, meso-, and bathypelagic, 0-1829 m |
| **ELH pattern** | Oviparous, eggs unknown, pelagic larvae |
| **Spawning** | Season: May (California)[a] |
| | Area: |
| | Mode: Synchronous hermaphrodites[b] |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE[c]

**Preanal length**
**Length at flexion**
**Length at transformation**[d]
**Sequence of fin development** Pectorals, caudal, dorsal, anal, pelvics
**Pigment**

- Genus: Preflexion larvae appear to be unpigmented except for pectoral fins
- Postflexion
  - —Heavy gut pigment
  - —Pigment patch at anal fin origin
  - —Pectoral fins
  - —Saddle in area of adipose fin
  - —Patch along midline over gut

**Diagnostic characters**

Distinguished from other species of *Alepisaurus* by

- Four preopercular spines
- Bony ridges on head
- Pigment patch at anal fin base

For family

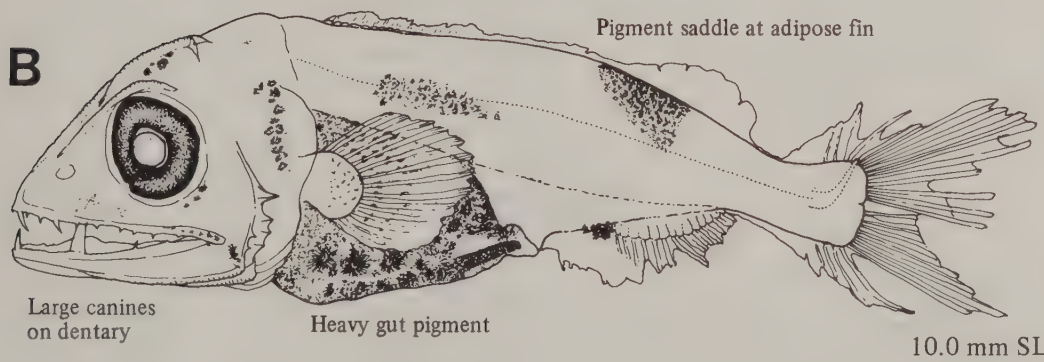
- Large head and mouth
- Prominent canines on dentary
- Small fins
- Short gut

[a] Fitch and Lavenberg 1968
[b] Okiyama 1984
[c] Illustrations of preflexion and postflexion *A. brevirostris* are provided for comparison.
[d] Transformation is gradual.

Ref: Okiyama 1984.

(Probably *Alepisaurus brevirostris*)

6.9 mm SL




10.0 mm SL

(Probably *Alepisaurus brevirostris*)

17.2 mm SL

Figures A, C, Rofen 1966c (specimens collected off Bermuda); B, Okiyama 1984 (Hawaiian specimen).

## MERISTICS

| | |
|---|---|
| **Vertebrae**[a] | Total: 30-X-31 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 8-8-8 |
| **Caudal fin** | 6-8, 10+9, 5-7 |
| **Pelvic fin** | Abdominal |
| | R: 8-8-8 |
| **Dorsal fin** | R: 11-X-13 |
| **Pectoral fin** | R: 18-X-19 |
| **Anal fin** | R: 10-X-13 |
| **Gill rakers**[b] | U: 3-3-3 L: 8-8-8 |
| | (T: 10-X-12) |

## LIFE HISTORY

| | |
|---|---|
| **Range**[c] | Brit. Col., 48°30′-55°N |
| **Ecology** | Mesopelagic, 300-800 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS (Ripe ovarian)

| | |
|---|---|
| **Diameter** | 0.83-0.98 mm |
| **No. of oil globules** | One |
| **Oil globule diameter** | 0.39-0.61 mm |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE (Postflexion only)

| | |
|---|---|
| **Preanal length** | ~70% SL |
| **Length at flexion** | |
| **Length at transformation** | Fin rays formed by 10.0 mm SL |
| **Sequence of fin development** | Pectorals, dorsal, anal, caudal, pelvics |

**Pigment**

- Small dorsal patches on peritoneum and hindgut

**Diagnostic characters**

- Pigment patch over hindgut (not solid as in other myctophiforms)
- Small preopercular spines

Distinguished from most myctophiforms by

- Lack of peritoneal pigment patches

For family

- Morphology
  - —Deep body
  - —Large head
  - —Large pectoral fin
- Round eye without choroid tissue
- Lightly pigmented

[a] Genus vertebral range 29-35.
[b] Gill raker counts vary geographically.
[c] Peden and Hughes (1986); previously only off Japan and Hawaii.

Ref: Maruyama 1970; Nafpaktitis 1977; Okiyama 1974, 1984.

*Neoscopelus* sp.

7.9 mm SL

Preopercular spines

Small dorsal pigment patches on peritoneum and hindgut

Figure A, Okiyama 1984 (southwestern Japan specimen).

Lanternfishes are worldwide in distribution, having 32 genera with 235 species found from the Arctic to the Antarctic. Myctophids generally have large eyes, large terminal mouths, photophores, and a black body color. In the Northeast Pacific, 20 species occur within two subfamilies: Myctophinae and Lampanyctinae. Most of the species (13) are members of the Lampanyctinae.

Myctophids are oviparous and presumably all produce planktonic eggs (Moser et al. 1984a). Eggs of only two species have been described: *Electrona rissoi* by Sanzo (1939) and *Lampanyctodes hectoris* by Robertson (1977). Eggs of both species are small (<1.0 mm), possess a single large oil globule, segmented yolk, smooth chorion, and at least *Lampanyctodes* eggs possess a fragile chorion. We have identified several types of myctophid eggs with these characteristics, in particular a fragile chorion. At least two of these types are probably *Diaphus* and *Stenobrachius* (based on egg characters and the presence of yolksac larvae of those species in the same samples).

The larval photophore complements and the sequence of appearance of photophores are useful characters. Most myctophids develop the Br2 during the larval period (in the Northeast Pacific the only exception is *Taaningichthys*). The Br2 is located posteroventral to the orbit but during transformation assumes a position beneath the orbit on the branchiostegal membrane. Three myctophine genera and eleven lampanyctine genera develop additional photophores during the larval period, with the Br2 always first to appear (Moser et al. 1984a). Of these 14 genera, only 4 are represented in our study area: *Ceratoscopelus*, *Lampadena*, *Diaphus*, and *Notoscopelus*.

The taxonomic section on myctophids here is arranged according to the intrafamilial classification of the group (Table 19), since certain larval characters reflect this classification (e.g., larval eye shape).

**Table 19**

**Myctophid taxa in the Northeast Pacific Ocean (see Moser et al. 1984a, Paxton 1972 [tribes], J. Nelson 1984).**

| | |
|---|---|
| **Subfamily Myctophinae** | (Eyes elliptical) |
| **Tribe Electronini** | |
| *Electrona rissoi* | |
| *Protomyctophum crockeri* | |
| *Protomyctophum thompsoni* | |
| **Tribe Myctophini** | |
| *Symbolophorus californiensis* | |
| **Tribe Gonichthyini** | |
| *Loweina rara* | |
| *Tarletonbeania crenularis* | |
| *Tarletonbeania taylori* | |
| **Subfamily Lampanyctinae** | (Eyes mostly rounded) |
| **Tribe Lampanyctini** | |
| *Ceratoscopelus townsendi* | |
| *Dorsadena (?=Lampadena) yaquinae** | |
| *Lampadena urophaos* | |
| *Lampanyctus fernae* | |
| *Lampanyctus jordani* | |
| *Lampanyctus regalis* | |
| *Lampanyctus ritteri* | |
| *Parvilux ingens* | |
| *Stenobrachius leucopsarus* | |
| *Stenobrachius nannochir* | |
| *Taaningichthys bathyphilus* | |
| **Tribe Diaphini** | |
| *Diaphus theta* | |
| **Tribe Gymnoscopelini** | |
| *Notoscopelus resplendens* | |

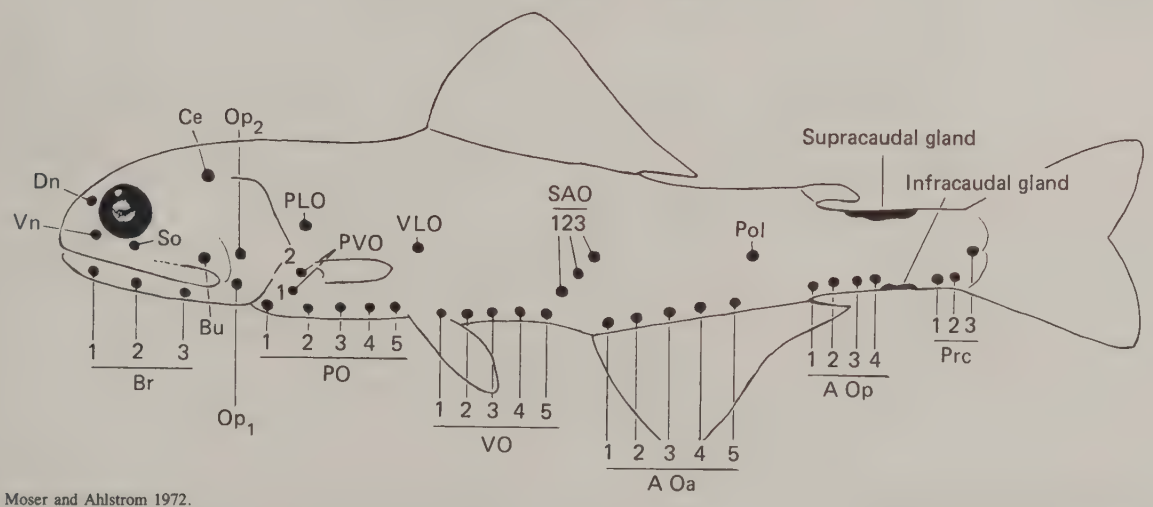
*See Moser et al. (1984a); larvae are unknown.

**Table 20**
**Meristic characters of the genera of Myctophidae (Moser et al. 1984a).**

| Taxon | Vertebrae | Fins | | | | | | Gill rakers | | Branchiostegals |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Dorsal | Anal | Pectoral | Pelvic | Caudal* Upper | Caudal* Lower | Upper | Lower | |
| **Myctophinae** | | | | | | | | | | |
| *Electrona* | 33-41 | 12-16 | 18-22 | 11-17 | 8 | 6-10 | 6-9 | 3-10 | 12-25 | 7-8 |
| *Protomyctophum* | 35-41 | 10-14 | 21-27 | 14-17 | 8-9 | 7-9 | 6-9 | 4-7 | 14-21 | 8-10 |
| *Symbolophorus* | 36-42 | 12-16 | 18-24 | 12-20 | 8 | 8-10 | 7-9 | 4-7 | 12-19 | 9 |
| *Loweina* | 37-39 | 10-13 | 13-17 | 9-12 | 7-9 | 6-7 | 6-7 | 2-3 | 5-10 | 9 |
| *Tarletonbeania* | 40-42 | 11-15 | 16-20 | 11-16 | 8 | 5-8 | 5-8 | 4-6 | 10-12 | 8 |
| **Lampanyctinae** | | | | | | | | | | |
| *Ceratoscopelus* | 35-38 | 13-15 | 13-16 | 12-15 | 8 | 6-7 | 6-7 | 3-5 | 9-16 | 9 |
| *Dorsadena* | | 14-15 | 12-14 | 15-16 | 8-9 | | | 4-5 | 12 | |
| *Lampadena* | 35-40 | 13-16 | 12-15 | 13-18 | 8 | 8 | 8-9 | 3-8 | 9-18 | 9 |
| *Lampanyctus* | 30-40 | 10-19 | 14-21 | 0-17 | 8 | 6-8 | 6-8 | 3-8 | 9-19 | 8-11 |
| *Parvilux* | 35-38 | 14-17 | 15-18 | 10-13 | 8 | 8 | 8-9 | 4-6 | 11-15 | 10-11 |
| *Stenobrachius* | 35-38 | 12-15 | 14-16 | 8-10 | 8 | 6-8 | 7-9 | 5-6 | 12-14 | 9-10 |
| *Taaningichthys* | 34-41 | 11-14 | 11-14 | 12-17 | 8 | 7-10 | 6-10 | 2-5 | 6-14 | 8-9 |
| *Diaphus* | 31-37 | 10-19 | 11-19 | 9-14 | 8 | 5-8 | 5-8 | 4-11 | 9-21 | 8-9 |
| *Notoscopelus* | 35-40 | 21-27 | 18-21 | 11-14 | 8-9 | 10-14 | 10-15 | 4-10 | 9-22 | 10 |

*Principal caudal fin ray count is 10+9. Only secondary fin ray counts are given.

PHOTOPHORE GROUP TERMINOLOGY




Moser and Ahlstrom 1972.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 32-X-34 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 8-8-8 |
| **Caudal fin** | 6-8, 10+9, 6-7 |
| **Pelvic fin** | Abdominal |
| | R: 8-8-8 |
| **Dorsal fin** | R: 13-X-15 |
| **Pectoral fin** | R: 13-X-16 |
| **Anal fin** | R: 18-19-20 |
| **Gill rakers** | U: 8-X-9 L: 18-X-21 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Oregon, 42-46°N |
| **Ecology** | Epi- and mesopelagic |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 0.80-0.84 mm |
| **No. of oil globules** | One |
| **Oil globule diameter** | 0.28 mm |
| **Yolk** | Segmented |
| **Envelope** | Smooth, fragile |
| **Hatch size** | |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 50% SL, with development 50-75% SL |
| **Length at flexion** | 6.2-7.0 mm SL |
| **Length at transformation** | ~10 mm SL |
| **Sequence of fin development** | Caudal, pectorals, anal, dorsal, pelvics |

**Pigment**

- Lower jaw symphysis (see 7.9 mm)
- Pectoral fin blade (see 6.3 mm)

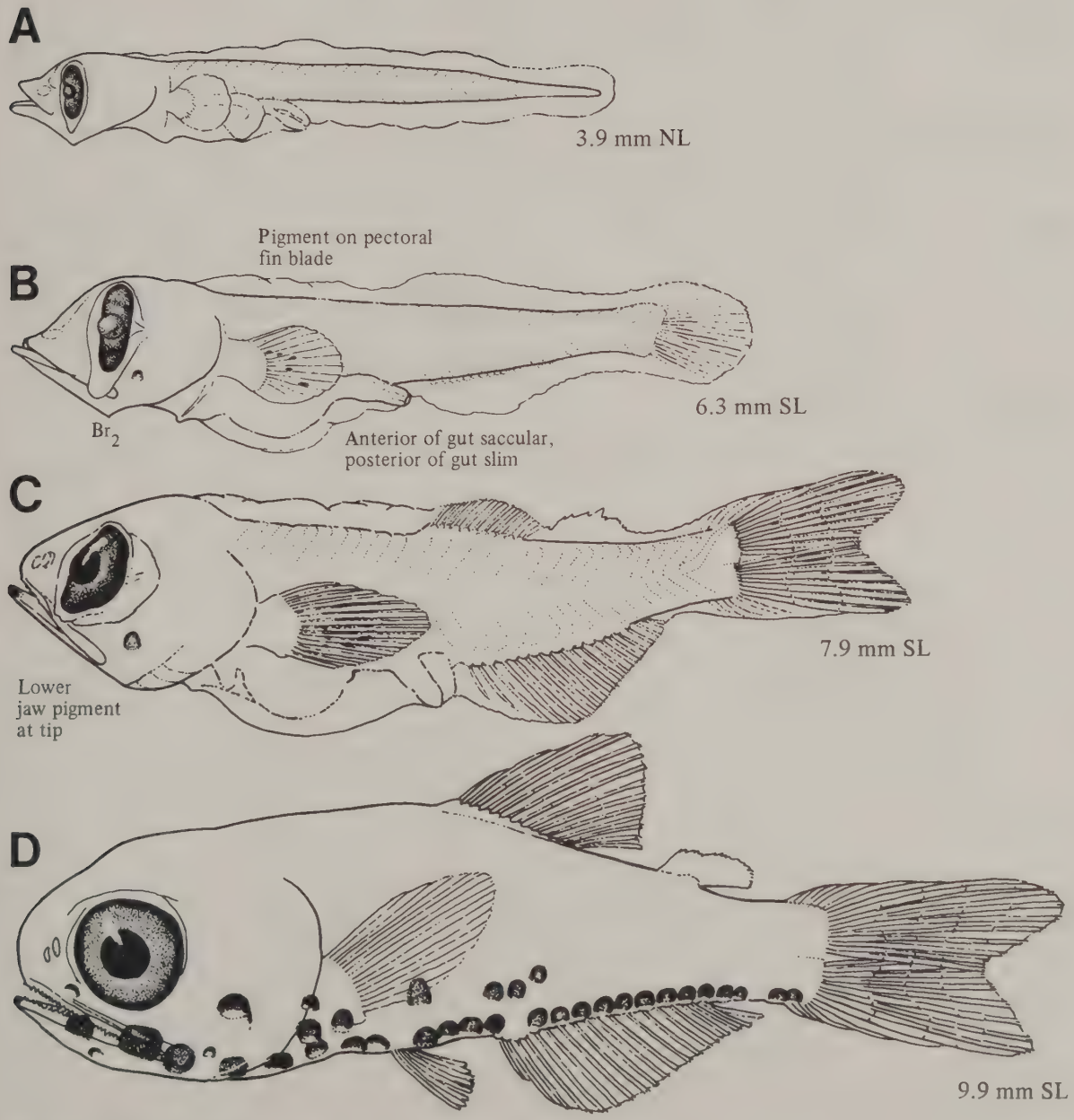
**Diagnostic characters**

- Photophores: Early Br2, usually forms at transformation in other species
- Morphology: Body moderately slender, head large
- Gut saccular, s-shaped
- Space between anus and anal fin origin but not as large as in *Protomyctophum* spp.
- Eyes very narrow
- Transforms earlier than most myctophids (9-10 mm SL)

Distinguished from other myctophids with elliptical eyes by

- Pigment on lower jaw tip and pectoral fin
- Lack of pigment on postanal body

Ref: Fahay 1983, Moser and Ahlstrom 1970, Moser et al. 1984a, Sanzo 1939, Tåning 1918.




Figures A–D, Moser and Ahlstrom 1970.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 36-X-37 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 8-X-12 | |
| **Caudal fin** | 7-9, 10+9, 7-8 | |
| **Pelvic fin** | Abdominal | |
| | R: 8-8-8 | |
| **Dorsal fin** | R: 11-12-13 | |
| **Pectoral fin** | R: 13-16-17 | |
| **Anal fin** | R: 19-22-24 | |
| **Gill rakers** | U: 4-5-6 | L: 14-16-18 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Washington, 46-48°30′N[a] |
| **Ecology** | Epi- and mesopelagic, 0-500 m |
| **ELH pattern** | Oviparous, eggs probably pelagic, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | 7.2-8.8 mm SL |
| **Length at transformation** | 12-15 mm SL, as large as 18 mm SL |
| **Sequence of fin development** | Caudal, pectorals, anal, dorsal, pelvics |

**Pigment**

- Preflexion larvae unpigmented
- Large melanophore over gut
- Postanal ventral melanophores in juveniles

**Diagnostic characters**

- Single spot over gut and lack of pigment elsewhere (flexion and postflexion larvae)

For Genus

Distinguished from other myctophids with elliptical eyes by

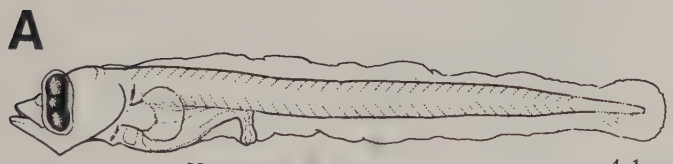
- Head small, body slender
- Gut short
- Wide space between anus and anal fin
- Larvae relatively lightly pigmented
- Eyes moderately narrow
- No enlarged fins

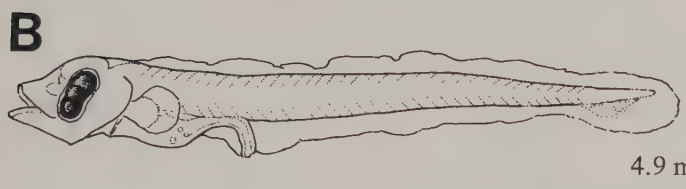
Distinguished from *P. thompsoni* by

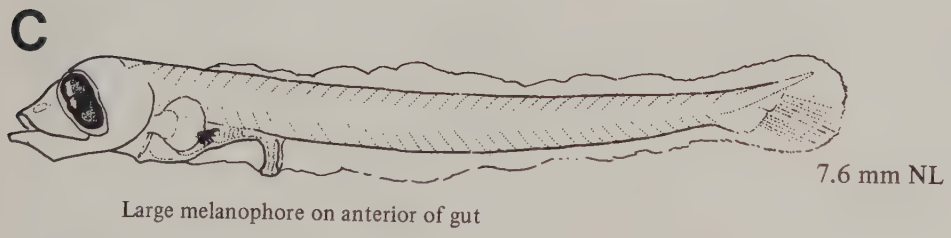
- Lack of postanal ventral melanophores in preflexion larvae and presence of only one spot over the gut in larger larvae

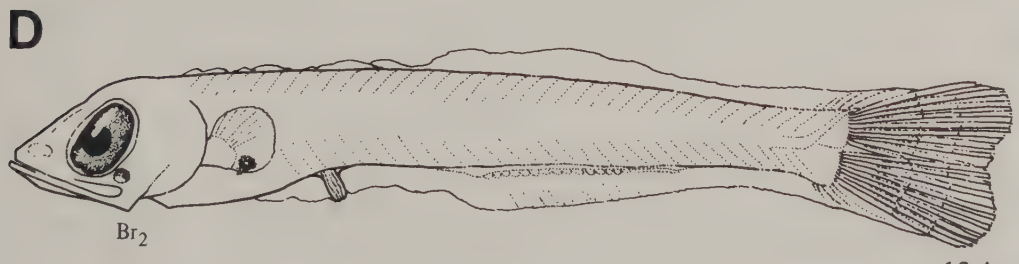
[a] Wisner 1974

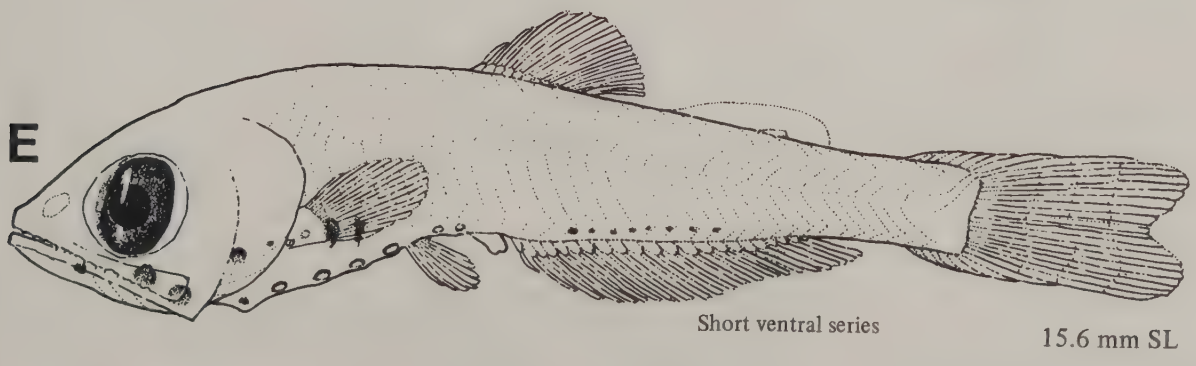
Ref: Moser and Ahlstrom 1970, Moser et al. 1984a.




Figures A–E, Moser and Ahlstrom 1970.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 37-38-39 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 8-X-12 |
| **Caudal fin** | 7-9, 10+9, 6-8 |
| **Pelvic fin** | Abdominal |
| | R: 8-8-8 |
| **Dorsal fin** | R: 11-12-13 |
| **Pectoral fin** | R: 14-15-17 |
| **Anal fin** | R: 21-23-25 |
| **Gill rakers** | U: 3-4-4 L: 13-14-16 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Cent. California, 34-38°N[a] to Bering Sea, 54-66°N |
| **Ecology** | Epi- and mesopelagic |
| **ELH pattern** | Oviparous, eggs probably pelagic, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | 7-10.0 mm SL |
| **Length at transformation** | 14-17 mm SL |
| **Sequence of fin development** | Caudal, pectorals, anal, dorsal, pelvics |

**Pigment**

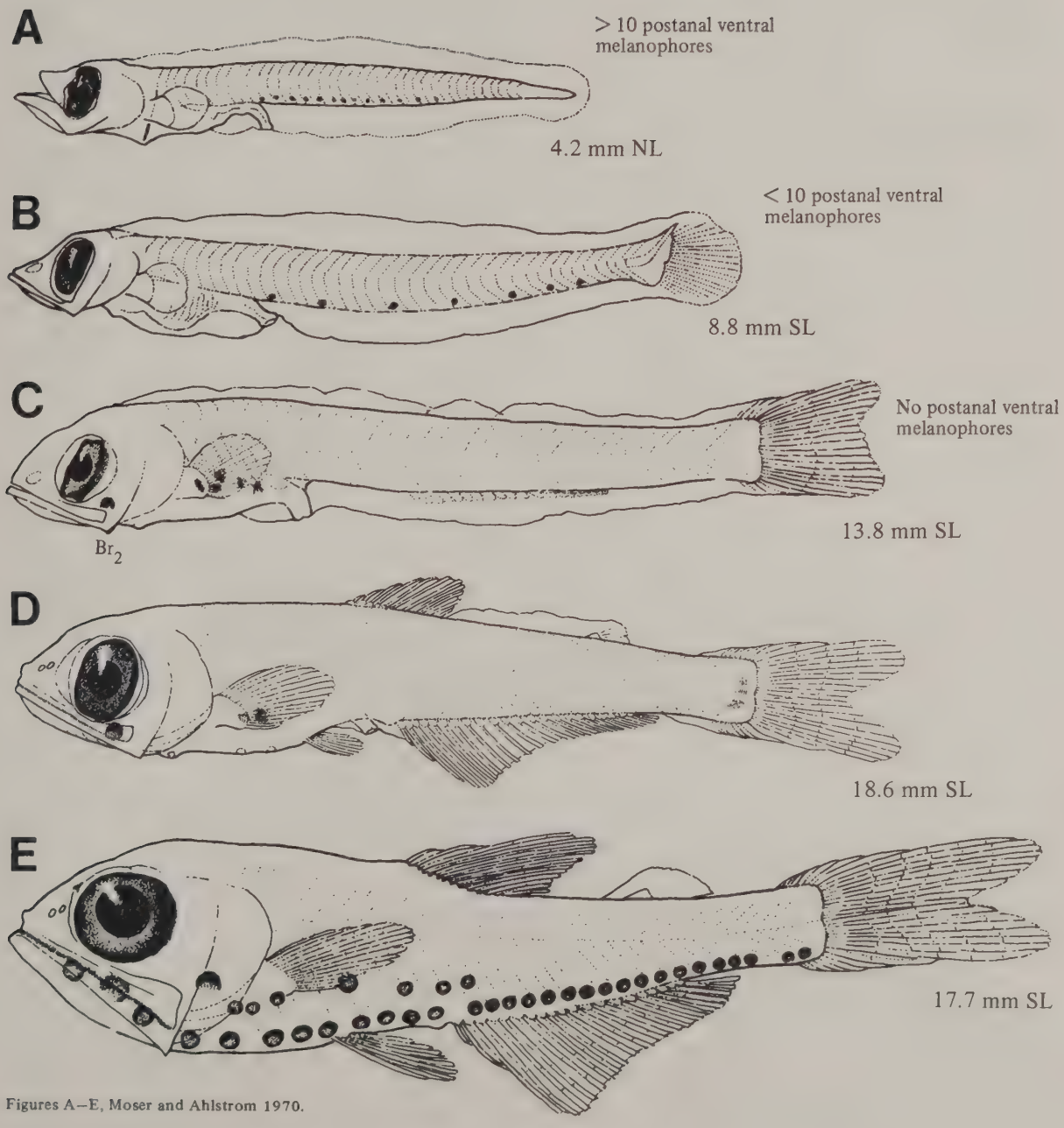
- Postanal ventral melanophores >10 in preflexion larvae decreasing to <10 in flexion larvae; not present in postflexion larvae
- Dorsolateral surface of gut in postflexion larvae

**Diagnostic characters**

- See *P. crockeri* (p. 150)
- Narrow eye
- Postanal ventral melanophore pattern

[a]R.N. Lea, Calif. Dep. Fish Game, 2201 Garden Road, Monterey, CA 93940, pers. commun., 19 Feb. 1987.

Ref: Moser and Ahlstrom 1970.




Figures A–E, Moser and Ahlstrom 1970.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 37-X-40 | |
| | Precaudal: 16-16-17 | |
| | Caudal: 22-23-23 | |
| **Branchiostegal rays** | 8-X-12 | |
| **Caudal fin** | 8-9, 10+9, 8-9 | |
| **Pelvic fin** | Abdominal | |
| | R: 8-8-8 | |
| **Dorsal fin** | R: 13-14-15 | |
| **Pectoral fin** | R: 15-17-19 | |
| **Anal fin** | R: 19-20-22 | |
| **Gill rakers** | U: 6-6-7 | L: 15-16-17 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Brit. Col., 48°30′-55°N |
| **Ecology** | Epi- and mesopelagic, 0-762 m |
| **ELH pattern** | Oviparous, eggs probably pelagic, pelagic larvae |
| **Spawning** | Season: Spring-summer[a] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | 7 yr[a] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | |
| **Length at flexion** | 8.0-10.0 mm SL |
| **Length at transformation** | 23.0-24.0 mm SL |
| **Sequence of fin development** | Pectorals, pelvics, caudal, anal, dorsal: pectoral fin base large and wing-shaped with supernumerary rays developing first |

**Pigment**

- Paired fins
- Lateral gut and anus
- Postanal ventral melanophores (preflexion)
- Also on snout, hindbrain, cleithral region, isthmus (lower jaw)

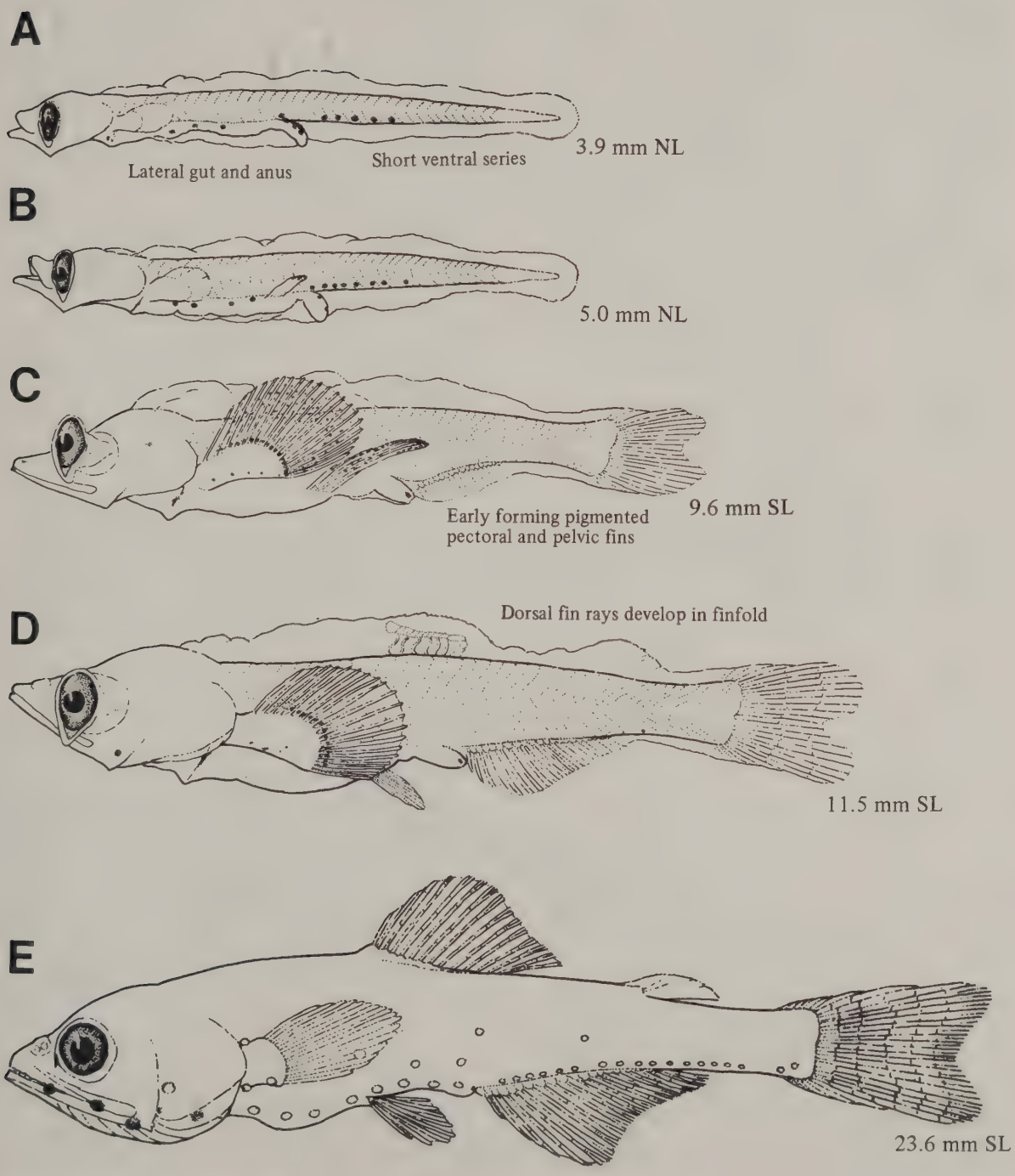
**Diagnostic characters**

Distinguished from other myctophids with elliptical eyes by

- Broad head
- Eyes slightly stalked with conical choroid mass (narrow)
- Early pectoral fin development, pectorals large with wing-shaped base
- Early pelvic fin development (unusual for myctophids)
- Dorsal fin rays develop in finfold
- Slightly enlarged median finfold
- Pigment on paired fins

[a] Fitch and Lavenberg 1968

Ref: Moser and Ahlstrom 1970, 1974; Moser et al. 1984a.




Figures A–E, Moser and Ahlstrom 1970.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 37-X-39 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 9-9-9 |
| **Caudal fin** | 6-7, 10+9, 6-7 |
| **Pelvic fin** | Abdominal |
| | R: X-X-X |
| **Dorsal fin** | R: X-X-X |
| **Pectoral fin** | R: 16-X-18 (larvae)[a] |
| | R: 9-X-12 (adults) |
| **Anal fin** | R: X-X-X |
| **Gill rakers** | U: X-X-X L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range**[b] | South of southern California to N. California, 38-42°N,[c] and Oregon, 42-46°N[d] |
| **Ecology** | Unknown |
| **ELH pattern** | Oviparous, eggs unknown, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 55% SL increasing with development to 80% SL |
| **Length at flexion** | 8.0-11.0 mm SL |
| **Length at transformation** | >20.0 mm SL |
| **Sequence of fin development** | Pectorals, caudal, anal and dorsal, pelvics |

**Pigment**

- Preflexion and flexion larvae
  - —Dark band of pigment between olfactory and optic lobes of the brain
  - —Blotch develops medially to each pectoral fin base
  - —Two blotches on dorsal surface of gut merging into one with development
  - —Three postanal body blotches
  - —Median finfold, lower pectoral ray
  - —Dorsal and ventral margins of caudal peduncle

**Diagnostic characters**

- Among largest myctophid larvae at transformation (>20.0 mm SL)
- Morphology: Early larvae slender but relative body depth doubles in later stages
- Only Br2 develops during larval period

Distinguished from all other myctophids except *Tarletonbeania crenularis* by

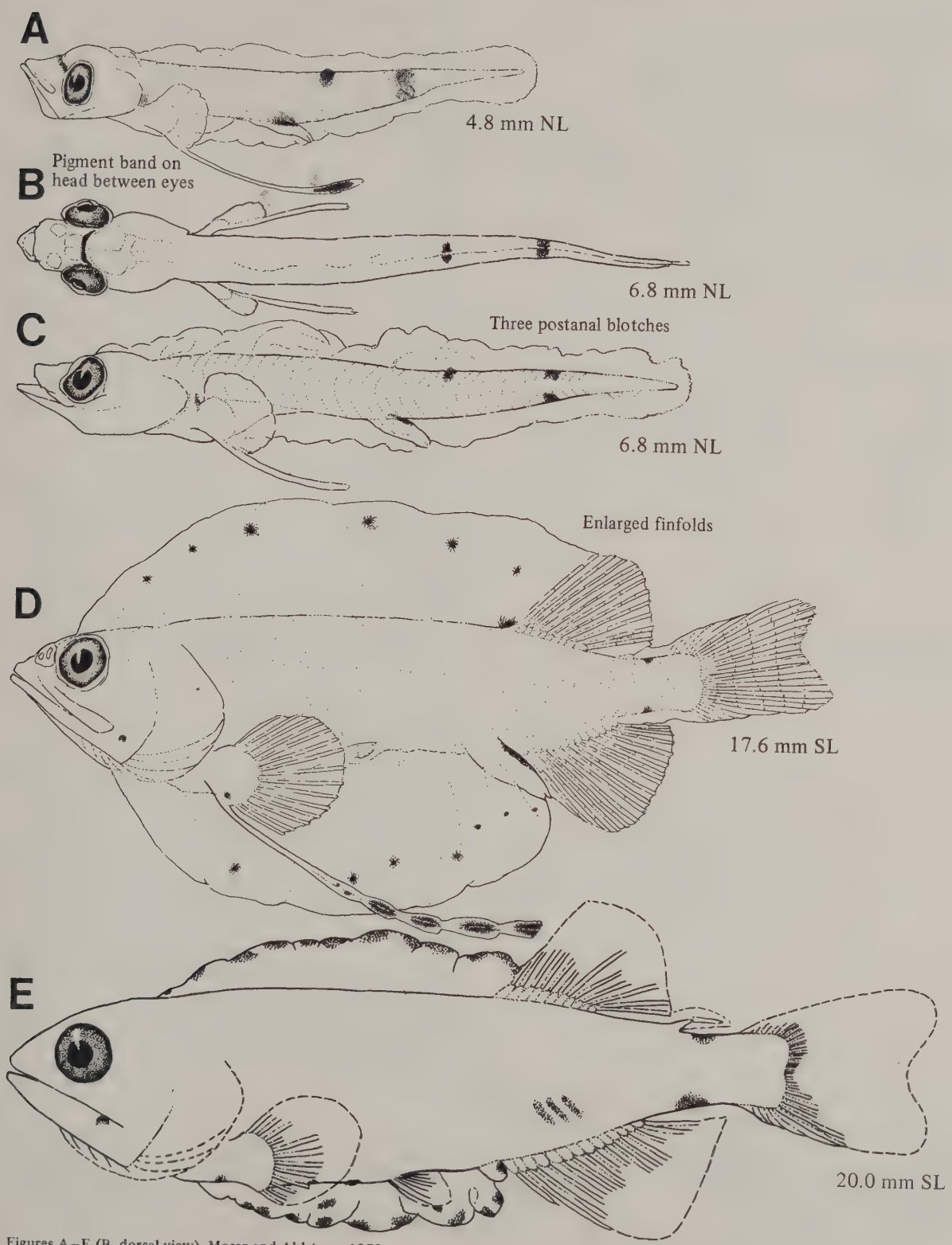
- Enlarged median finfolds

Distinguished from *T. crenularis* (p. 158) by

- Eye moderately narrow, no choroid tissue on ventral surface of eye
- Pigment: Band on head between eyes

[a] Larvae have six more pectoral fin rays than adults.
[b] Range for larvae; adults widespread.
[c] Moser and Ahlstrom 1970
[d] Richardson and Pearcy 1977

Ref: Moser and Ahlstrom 1970.




Figures A–E (B, dorsal view), Moser and Ahlstrom 1970.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 39-41-42 |
| | Precaudal: 17-17-19 |
| | Caudal: 22-23-24 |
| **Branchiostegal rays** | 8-9-11 |
| **Caudal fin** | 5-7, 10+9, 5-7 |
| **Pelvic fin** | Abdominal |
| | R: 7-8-9 |
| **Dorsal fin** | R: 11-12-14 |
| **Pectoral fin** | R: 11-13-15 |
| **Anal fin** | R: 17-18-20 |
| **Gill rakers** | U: 4-5-6 L: 10-11-12 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Bering Sea, 54-66°N |
| **Ecology** | Epi- and mesopelagic, 0-832 m |
| **ELH pattern** | Oviparous, eggs probably pelagic, pelagic larvae |
| **Spawning** | Season: Winter-spring;[a] Nov-Feb[b] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 50% SL at hatching, 70% SL at 13-14 mm SL, ⩾50% SL at transformation |
| **Length at flexion** | 7.5-10.5 mm SL |
| **Length at transformation** | ~19-21 mm SL |
| **Sequence of fin development** | Caudal, pectorals, anal, dorsal, pelvics |

**Pigment**

- Preflexion: Postanal band located at posteriormost 4-5 myomeres, on anus, and over gut
- Flexion: Head, finfold, 1-2 postanal melanophores
- Postflexion: Dorsal midline anterior to fin

**Diagnostic characters**

Distinguished from *Loweina rara* (p. 156) by

- See *L. rara*

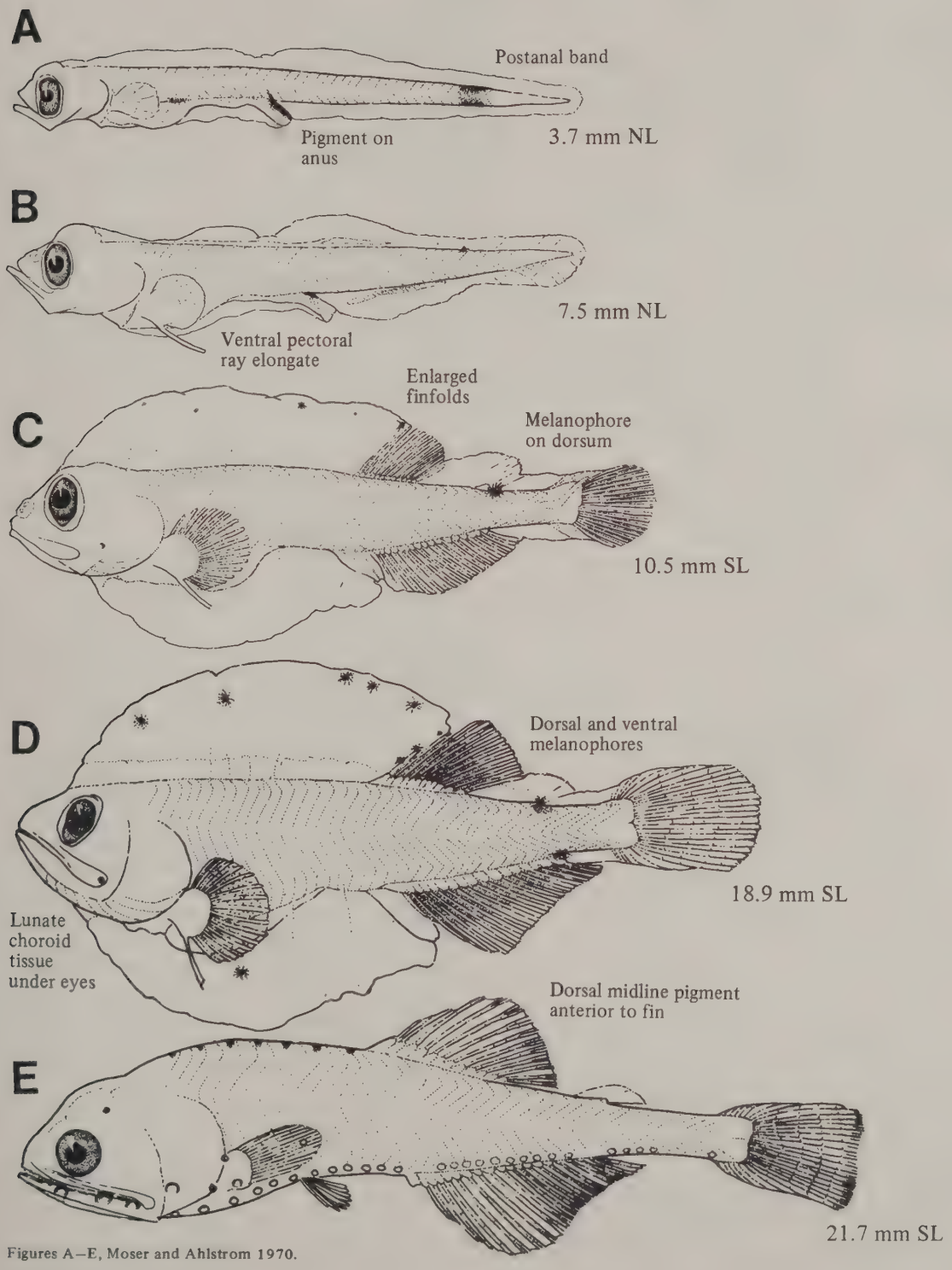
Distinguished from all other myctophids except *L. rara* by

- Finfold: Dorsal and ventral finfolds greatly enlarged and conspicuously pigmented (more on dorsal)
- Eyes narrow with lunate choroid mass
- Only Br2 develops during larval period
- Enlarged ventral pectoral fin ray (lost during transformation)
- Postanal pigment band

Note: *T. taylori* adults occur in the area but their larvae are inadequately known. Pertseva-Ostroumova (1964) illustrated a 12-mm SL larva as *T. crenularis taylori*, but it has no features that distinguish it from *T. crenularis*.

[a] Ahlstrom 1965
[b] Wang 1981

Ref: Moser and Ahlstrom 1970, 1974; Moser et al. 1984a.




Figures A–E, Moser and Ahlstrom 1970.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae**[a] | Total: 35-36-38 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 8-X-12 | |
| **Caudal fin** | 6, 10+9, 6-7 | |
| **Pelvic fin** | Abdominal | |
| | R: 8-X-9 | |
| **Dorsal fin** | R: 13-14-15 | |
| **Pectoral fin** | R: 12-X-14 | |
| **Anal fin**[a] | R: 13-X-14 | |
| **Gill rakers**[a] | U: 4-4-5 | L: 10-11-12 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Brit. Col., 48°30′-55°N |
| **Ecology** | Epi- and mesopelagic |
| **ELH pattern** | Oviparous, eggs probably pelagic, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE[b]

| | |
|---|---|
| **Preanal length** | 46% SL, with development 58-61% SL |
| **Length at flexion** | 6.2-7.0 mm SL |
| **Length at transformation** | 16.6-21.0 mm SL (may be larger) |
| **Sequence of fin development** | Caudal, pectorals, anal, dorsal, pelvics |

**Pigment**

- Generally light pigment
- Pair of melanophores at each side of gut at point of divergence of the free terminal section (retained throughout but becoming embedded with development)
- Series (∼11) of postanal ventral melanophores in early larvae, with development usually coalescing to a single spot in postflexion larvae

**Diagnostic characters**

- Photophores: Br2 (7.0 mm SL); Vn (7.8 mm SL); PLO (8.7 mm SL; develop and remain at pectoral fin base throughout larval period but at transformation they migrate dorsally to just below the lateral line); PO5 (9.0 mm SL); during transformation the remaining photophores develop sequentially

Distinguished from other myctophids with round eyes by

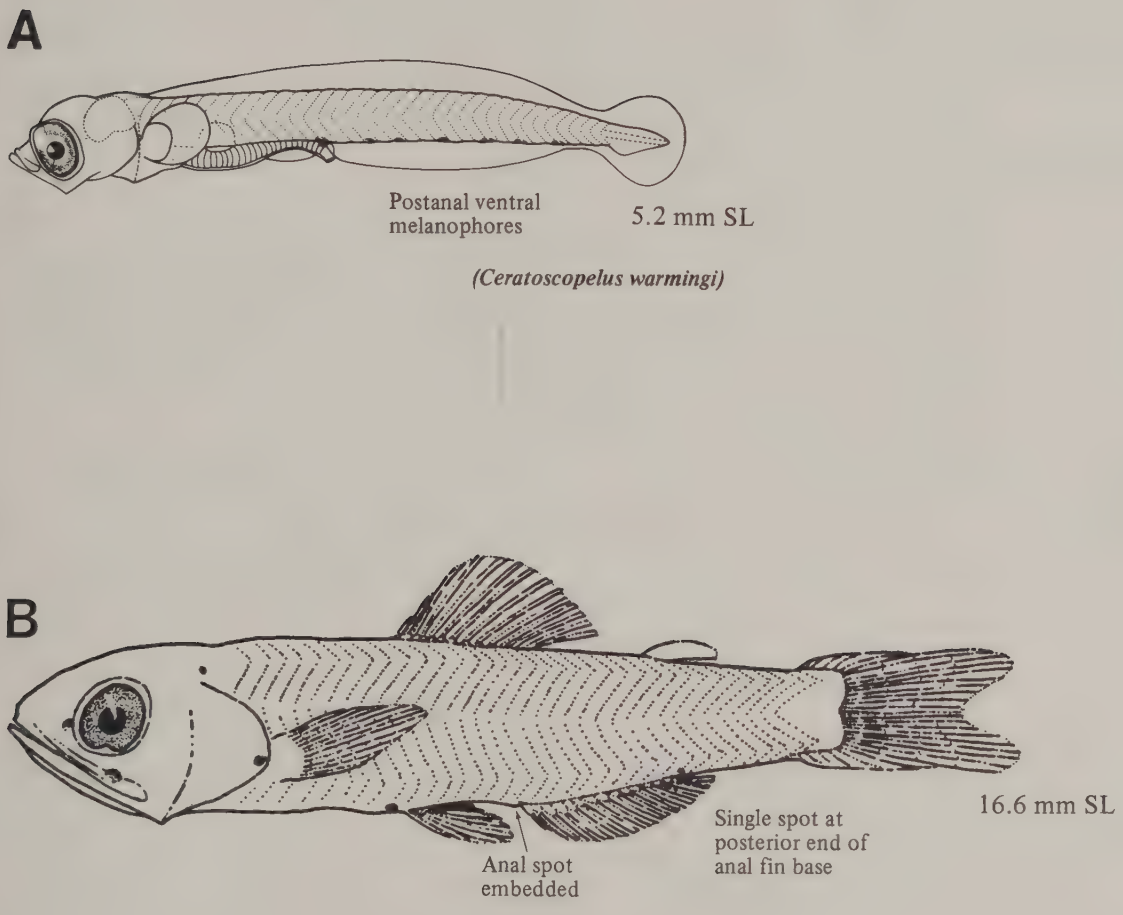
- Eye elliptical in preflexion larvae (although not perfectly round, the eye is easily differentiated from the narrow eyes of larval Myctophinae)
- Single spot at anus
- Preflexion larvae with ∼11 postanal ventral melanophores

[a] Peden and Hughes (1986) report counts for the following meristic characters:

| | |
|---|---|
| Precaudal vertebrae | 16 |
| Caudal vertebrae | 20 |
| Anal fin rays | 15 |
| Gill rakers | 6−7+1+15 |

[b] H.G. Moser, NMFS Southwest Fish. Cent., P.O. Box 271, La Jolla, CA 92038, pers. commun., 9 Jan. 1984. Illustrations of small larvae are unavailable. A figure of a preflexion larva of *C. warmingi* is included for comparison.

Ref: Moser and Ahlstrom 1974, Moser et al. 1984a.




*(Ceratoscopelus warmingi)*

Figure A, Miller et al. 1979 (Hawaiian specimen); B, Moser and Ahlstrom 1974.

## MERISTICS

| | |
|---|---|
| **Vertebrae**[a] | Total: 35-36-36 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 9-X-10 |
| **Caudal fin** | 8-9, 10+9, 8-9 |
| **Pelvic fin** | Abdominal |
| | R: 8-8-8 |
| **Dorsal fin** | R: 14-15-16 |
| **Pectoral fin** | R: 15-16-17 |
| **Anal fin** | R: 13-13-14 |
| **Gill rakers**[a] | U: 3-4-5 L: 9-X-11 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Washington, 46-48°30′N |
| **Ecology** | Epi- and mesopelagic |
| **ELH pattern** | Oviparous, eggs probably pelagic, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 50% SL |
| **Length at flexion** | By 5-6 mm SL |
| **Length at transformation** | 19.6 mm SL |
| **Sequence of fin development** | Caudal, pectorals, anal, dorsal, pelvics |

**Pigment** - Genus[b]

(Pigment for *L. urophaos* more restricted to dorsal and ventral midline)

- Brain, nape, gut, swimbladder
- Double row of large melanophores along dorsal midline with an opposing double row of postanal ventral midline melanophores
- Some with more numerous dorsal and ventral melanophores and internal pigment above the notochord

**Diagnostic characters**

- Photophores: Br2, PLO, PO5, and Vn+PO1 develop during larval period

Distinguished from other myctophids with round eyes by

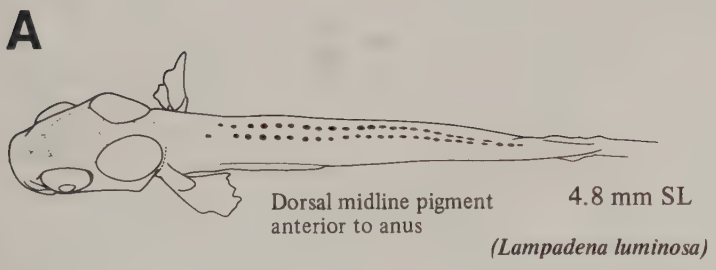
- Dorsal midline pigment anterior to anus

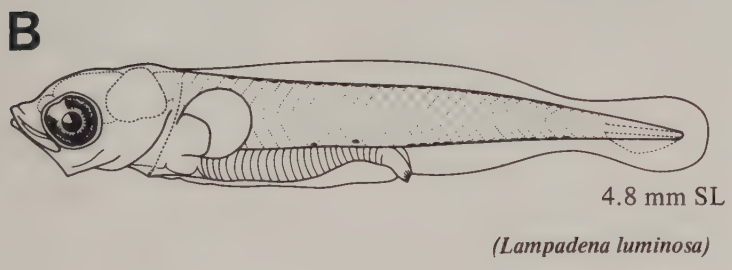
[a] Peden and Hughes (1986) report counts of the following meristic characters:

| | |
|---|---|
| Total vertebrae | 38 |
| Precaudal vertebrae | 17 |
| Caudal vertebrae | 21 |
| Gill rakers | 5+1+12 |

[b] Discussion of pigment is based on genus, since illustrations of small larvae of *L. urophaos* are not available. Figures of a preflexion larva of *L. luminosa* are included for comparison.

Ref: Moser and Ahlstrom 1972; Moser et al. 1984a; H.G. Moser, NMFS Southwest Fish. Cent., P.O. Box 271, La Jolla, CA 92038, unpubl.



Figures A–B (A, dorsal view), Miller et al. 1979 (Hawaiian specimens); C–D, Moser and Ahlstrom 1972.

Of the four *Lampanyctus* species found in the study area, we can identify larvae of only *L. regalis* and *L. ritteri*. Generic characters include:

- Pigment above brain
- Myoseptal trunk pigment increasing during postflexion to cover most of anterior trunk at transformation
- Slender body; deepens and becomes robust in some species
- Deep head
- Gut short in early preflexion larvae; with development lengthens to midbody

The following meristic information may aid in identifying the four *Lampanyctus* species.

| | | | Fins | | | |
|---|---|---|---|---|---|---|
| Species | Distribution | Vertebrae | Dorsal | Anal | Pectoral | Pelvic |
| *Lampanyctus fernae* | N. Calif. - Oregon | 36-38 | 12-14 | 16-18 | 12-14 | 8 |
| *Lampanyctus jordani* | S. Calif. - Bering Sea | 38-40 | 10-12 | 17-20 | 14-17 | 8 |
| *Lampanyctus regalis* | SSC - Bering Sea | 36-39 | 14-16 | 17-19 | 12-14 | 8 |
| *Lampanyctus ritteri* | SSC - Bering Sea | 35-38 | 12-15 | 16-19 | 10-13 | 8-9 |

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 36-X-39 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 9-9-9 | |
| **Caudal fin** | 6-8, 10+9, 6-8 | |
| **Pelvic fin** | Abdominal | |
| | R: 8-8-8 | |
| **Dorsal fin** | R: 14-15-16 | |
| **Pectoral fin** | R: 12-13-14 | |
| **Anal fin** | R: 17-17-19 | |
| **Gill rakers** | U: 4-4-4 | L: 9-10-10 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Bering Sea, 54-66°N |
| **Ecology** | Epi- and mesopelagic |
| **ELH pattern** | Oviparous, eggs probably pelagic, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE[a]

| | |
|---|---|
| **Preanal length** | 38% SL preflexion, 54% SL at flexion, 67% SL postflexion |
| **Length at flexion** | >4 mm SL, <7 mm SL |
| **Length at transformation** | >10 mm SL, <28 mm SL |
| **Sequence of fin development** | Caudal, pectorals, anal, dorsal, pelvics (pelvics may form early) |

**Pigment**

- Preflexion larvae are unpigmented except for spots on lower jaw tip and snout
- Head: Jaw tips, internal along snout, postorbital, opercle
- Pectoral and pelvic fins
- Large spot at adipose fin

**Diagnostic characters**

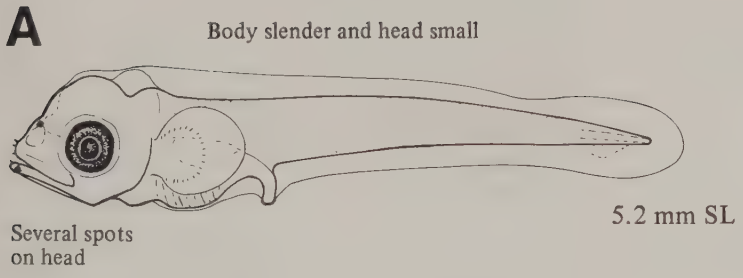
- Photophores: Only Br2 develops during larval period (7.8 mm SL); remaining photophores develop synchronously at end of transformation period

Distinguished from other myctophids with round eyes by

- Morphology: Initially slender with a small head; with development a deep broad head and body with elongate snout develops; pectorals moderately large
- Jaws large with teeth
- Pigment: Large spot at adipose fin

[a]H.G. Moser, NMFS Southwest Fish. Cent., P.O. Box 271, La Jolla, CA 92038, pers. commun., 9 Jan. 1984.

Ref: Moser et al. 1984a; Moser, unpubl.



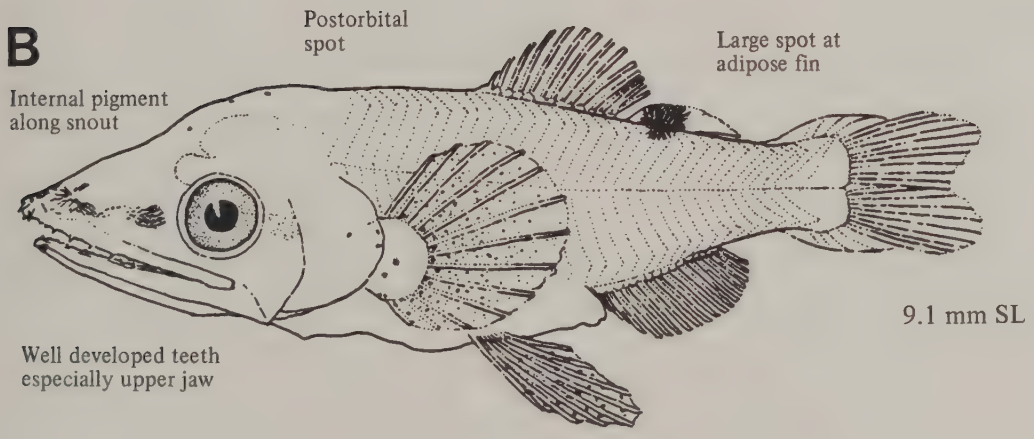




Figure A, NWAFC original (B. Vinter); B, Moser and Ahlstrom 1974.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 35-36-38 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 9-9-9 | |
| **Caudal fin** | 7-8, 10+9, 7-8 | |
| **Pelvic fin** | Abdominal | |
| | R: 8-X-9 | |
| **Dorsal fin** | R: 12-13-15 | |
| **Pectoral fin** | R: 10-11-13 | |
| **Anal fin** | R: 16-18-19 | |
| **Gill rakers** | U: 4-4-4 | L: 9-10-11 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Bering Sea, 54-66°N |
| **Ecology** | Epi-, meso-, and bathypelagic, 20-1098 m |
| **ELH pattern** | Oviparous, eggs probably pelagic, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE[a]

| | |
|---|---|
| **Preanal length** | <50% SL in preflexion, with development 50% SL |
| **Length at flexion** | >4 mm SL, ~6 mm SL |
| **Length at transformation** | >10 mm SL |
| **Sequence of fin development** | Caudal, pectorals, anal, dorsal, pelvics |

**Pigment**

- Head: Snout, lower jaw, opercle; several spots anterodorsal to eye persist throughout development
- Dorsal and ventral midline on tail
- Anteroventral to liver

**Diagnostic characters**

- See *L. regalis* (p. 166)
- Photophores: Only Br2 develops during larval period; remaining photophores develop synchronously at end of transformation period

Distinguished from other myctophids with round eyes by

- See *L. regalis*

Distinguished from *L. regalis* by

- Morphology: Body and head moderately deep; jaws, teeth, and pectorals moderate in size

[a] H.G. Moser, NMFS Southwest Fish. Cent., P.O. Box 271, La Jolla, CA 92038, pers. commun., 9 Jan. 1984.

Ref: Ahlstrom 1965; Moser and Ahlstrom 1974; Moser, unpubl.

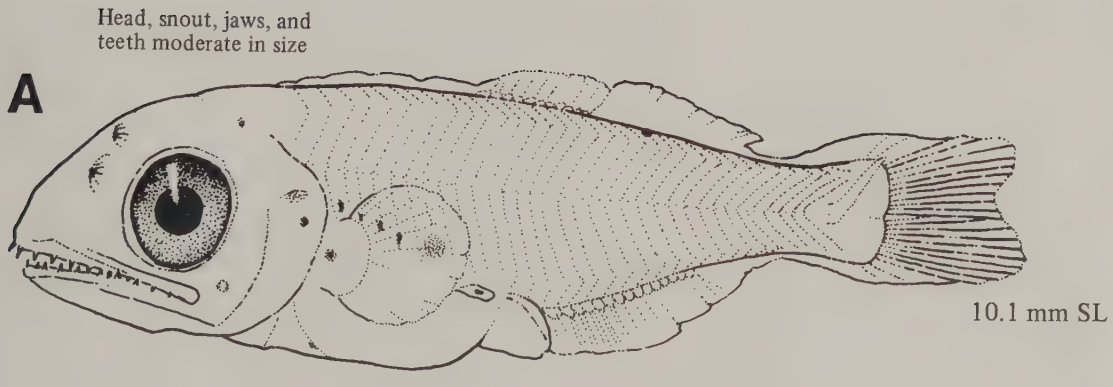



Figure A, Moser and Ahlstrom 1974.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 36-37-38 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 8-X-12 | |
| **Caudal fin** | 8, 10+9, 8 | |
| **Pelvic fin** | Abdominal | |
| | R: 8-8-8 | |
| **Dorsal fin** | R: 14-X-17 | |
| **Pectoral fin** | R: 10-X-13 | |
| **Anal fin** | R: 15-X-18 | |
| **Gill rakers** | U: 4-5-6 | L: 12-13-15 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Oregon, 42-46°N |
| **Ecology** | Epi- and mesopelagic |
| **ELH pattern** | Oviparous, eggs probably pelagic, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL, with development increasing to 50% SL |
| **Length at flexion** | |
| **Length at transformation** | |
| **Sequence of fin development** | Caudal, pectorals, anal, dorsal, pelvics |

**Pigment**

- Early preflexion larvae probably unpigmented with pigment developing by flexion stage
- Postflexion larvae have pigment above brain, internally above otic region, lateral to cleithrum, and in anteroventral region of liver
- Postanal body with 1-2 dorsal midline melanophores and 1 ventral midline melanophore at caudal peduncle

**Diagnostic characters**

- Photophores: Only Br2 forms during the larval period

Distinguished from other myctophids with round eyes by

- Dorsal midline melanophores restricted to 1-2 spots posterior to adipose fin
- Head and eyes large with the body tapered

Ref: Moser and Ahlstrom 1974; Moser et al. 1984a; H.G. Moser, NMFS Southwest Fish. Cent., P.O. Box 271, La Jolla, CA 92038, unpubl.

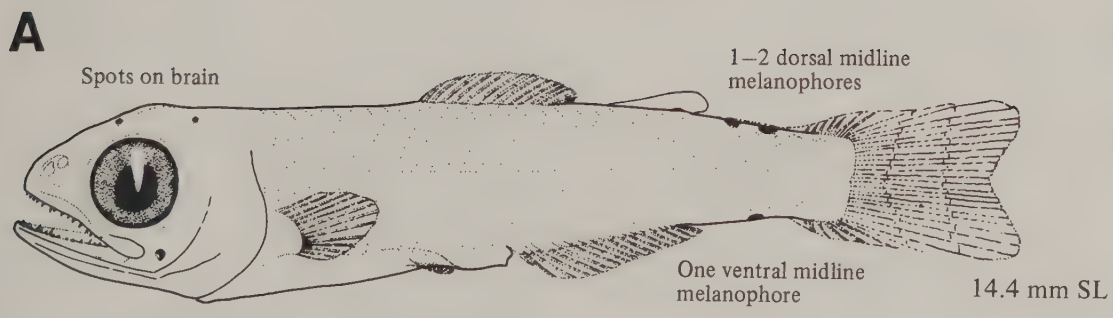



Figure A, Moser and Ahlstrom 1974.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 36-37-38 |
| | Precaudal: 14-15-16 |
| | Caudal: 20-21-22 |
| **Branchiostegal rays** | 8-X-12 |
| **Caudal fin** | 6-8, 10+9, 7-8 |
| **Pelvic fin** | Abdominal |
| | R: 8-8-8 |
| **Dorsal fin** | R: 12-X-14 |
| **Pectoral fin** | R: 9-X-11 |
| **Anal fin** | R: 14-15-16 |
| **Gill rakers** | U: 5-5-6 L: 12-13-14 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Bering Sea, 54-66°N |
| **Ecology** | Epi-, meso-, and bathypelagic, 0-2896 m |
| **ELH pattern** | Oviparous, eggs probably pelagic, pelagic larvae |
| **Spawning** | Season: Winter-spring (Oregon);[a] Nov-Aug (Calif.);[b] Dec-Feb (Moss Landing, Calif.)[c] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | 3 yr (California)[b] |
| | 4 yr (Oregon)[a] |
| **Longevity** | 3-4 yr[b] |

[a] Smoker and Pearcy 1970
[b] Fast 1960
[c] Wang 1981

Ref: Ahlstrom 1965, 1972; Moser and Ahlstrom 1974.

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | >5.3 mm SL, ~6-7 mm SL |
| **Length at transformation** | >12.5 mm SL; 10-19 mm SL[b] |
| **Sequence of fin development** | Caudal, pectorals, anal, dorsal, pelvics |

**Pigment**

- Gut melanophores: Early preflexion, lateral spots at pectoral fin base, midgut, and anus
- Series of postanal ventral melanophores (>15) in preflexion larvae which coalesce to 2 or 3 spots in postflexion larvae
- Postflexion: Above brain, nape, and embedded in trunk myosepta on each side of dorsal midline (not shown)

**Diagnostic characters**

- Photophores: Only Br2 forms in the larval period

Distinguished from other myctophids with round eyes by

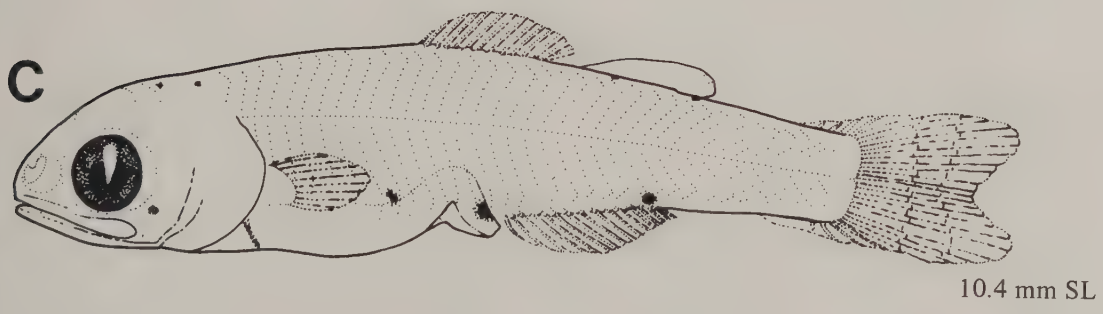
- Gut pigment: Three spots in preflexion larvae (pectoral fin base, midgut, and anus); with development spots are retained, although their position shifts posteriorly
- Series of postanal ventral melanophores (>15) in preflexion larvae

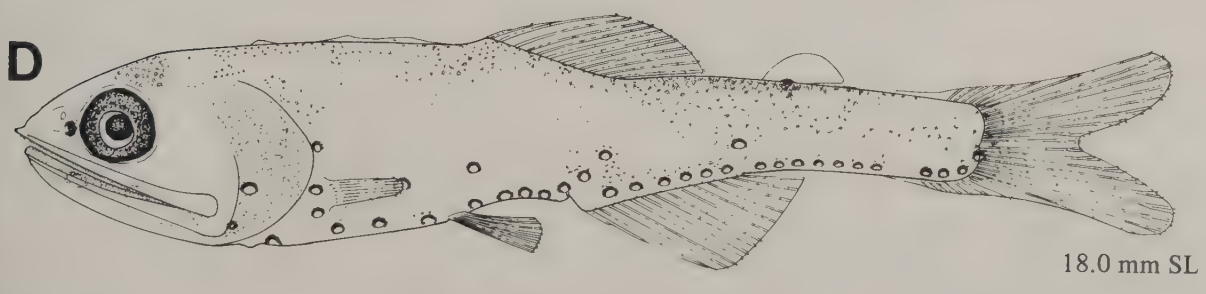
Distinguished from *Diaphus theta* (p. 176) by

- Lack of pigment at caudal base
- Number of postanal ventral melanophores (>15): Preflexion larvae usually have >20; postanal ventral midline melanophores appear more embedded in *D. theta* (see figure)

*S. nannochir* larvae are unknown. The following meristic information may aid in identification.

| | |
|---|---|
| Total vertebrae | 36-38 |
| Dorsal fin rays | 13-14 |
| Anal fin rays | 14-16 |
| Pectoral fin rays | 9-10 |
| Pelvic fin rays | 8 |




Figures A–B, D, NWAFC originals (B. Vinter); C, Moser and Ahlstrom 1974.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 34-X-36 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 8-X-12 |
| **Caudal fin** | X, 10+9, X |
| **Pelvic fin** | Abdominal |
| | R: 8-8-8 |
| **Dorsal fin** | R: 11-X-14 |
| **Pectoral fin** | R: 12-X-14 |
| **Anal fin** | R: 12-13-14 |
| **Gill rakers** | U: 3-3-3 L: 6-X-10 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Cent. California, 34-38°N,[a] to Oregon, 42-46°N |
| **Ecology** | Meso- and bathypelagic |
| **ELH pattern** | Oviparous, eggs probably pelagic, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

**Preanal length**
**Length at flexion**
**Length at transformation**
**Sequence of fin development** Caudal, pectorals, anal, dorsal, pelvics
**Pigment** - Genus[b]

- Above brain, otic region
- One to several opposing melanophores at postanal dorsal and ventral midline
- Late postflexion larvae may develop melanophores along each side of dorsal midline
- Base of caudal rays
- Series of embedded melanophores above spinal column

**Diagnostic characters** - Genus

- No photophores in larvae

Distinguished from other myctophids with round eyes by

- Morphology: Body slender, lower jaw projects beyond upper jaw
- Embedded melanophores above spinal column
- Opposing dorsal and ventral melanophores on caudal peduncle

[a] Wisner 1974
[b] Information on *T. minimus* larvae is provided for comparison since *T. bathyphilus* larvae are unknown.

Ref: Moser et al. 1984a; H.G. Moser, NMFS Southwest Fish. Cent., P.O. Box 271, La Jolla, CA 92038, unpubl.

*Taaningichthys minimus*

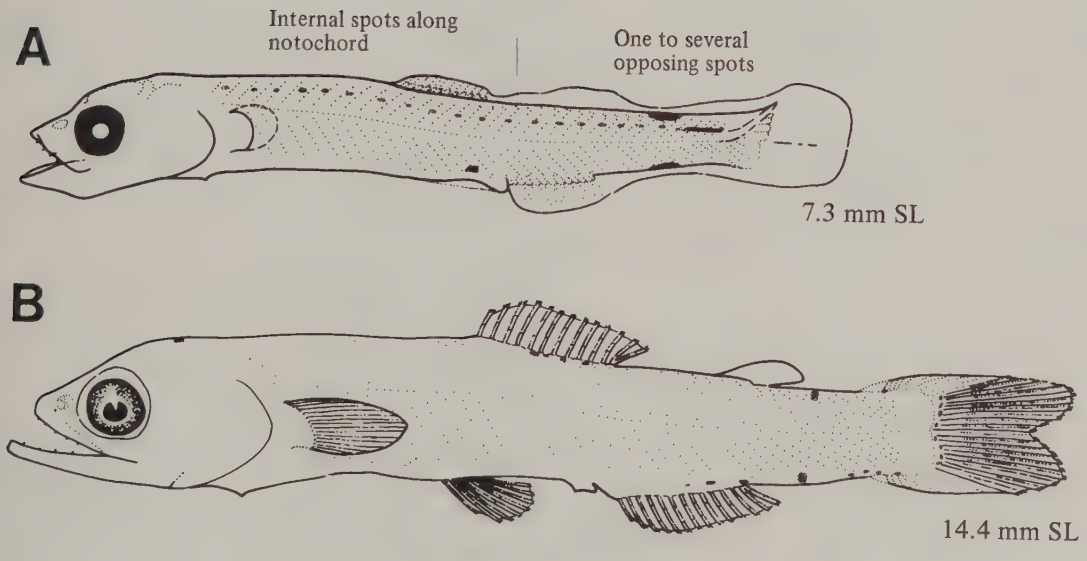



Figure A–B, Moser and Ahlstrom 1972 (southwestern Pacific specimens).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 34-35-36 |
| | Precaudal: 15-16-16 |
| | Caudal: 18-19-20 |
| **Branchiostegal rays** | 9-9-9 |
| **Caudal fin** | 6-8, 10+9, 6-8 |
| **Pelvic fin** | Abdominal |
| | R: 7-X-8 |
| **Dorsal fin** | R: 11-13-15 |
| **Pectoral fin** | R: 10-X-12 |
| **Anal fin** | R: 12-X-14 |
| **Gill rakers** | U: 5-X-7 L: 12-15-16 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Bering Sea, 54-66°N |
| **Ecology** | Epi- and mesopelagic, 0-792 m |
| **ELH pattern** | Oviparous, eggs probably pelagic, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | |
| **Length at flexion** | <6.9 mm SL |
| **Length at transformation** | |
| **Sequence of fin development** | Caudal, pectorals, anal, dorsal, pelvics |

**Pigment**

- Head unpigmented
- Anteroventral surface of liver, midgut, base of caudal fin rays, swimbladder
- Postanal ventral melanophores in preflexion: Numerous (<15)

**Diagnostic characters**

- Number of photophores in larvae[a]

Distinguished from other myctophids with round eyes by

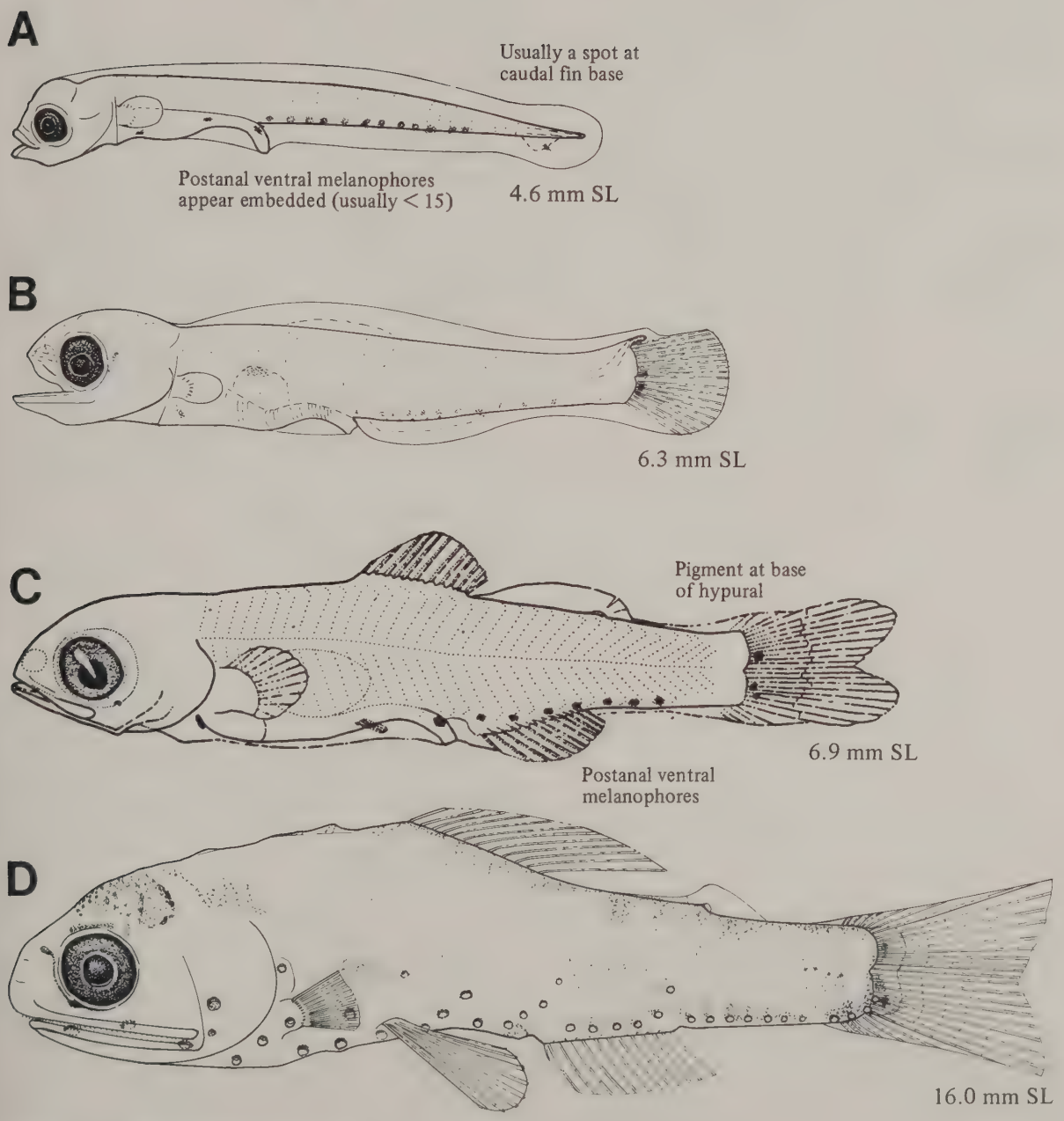
- Body moderately slender
- Head moderate in size, unpigmented
- Postanal ventral melanophores (<15)
- Melanophores at base of caudal fin rays

Distinguished from *Stenobrachius leucopsarus* (p. 172) by

- See *S. leucopsarus*

[a] Sequence of formation of photophores: Br2, PO5, PO1 [VO1, PO2, OP2, VO5, PO3, PO4, VLO] (photophores in brackets appear in late larval period).

Ref: Moser and Ahlstrom 1974.




Figures A–B, D, NWAFC originals (B. Vinter); C, Moser and Ahlstrom 1974.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 35-37-38 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 9-9-9 |
| **Caudal fin** | 11-14, 10+9, 10-14 |
| **Pelvic fin** | Abdominal |
| | R: 8-X-9 |
| **Dorsal fin** | R: 21-22-23 |
| **Pectoral fin** | R: 11-12-13 |
| **Anal fin** | R: 18-19-20 |
| **Gill rakers** | U: 6-6-7 L: 13-14-15 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Brit. Col., 48°30′-55°N |
| **Ecology** | Epi- and mesopelagic |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS - Genus

| | |
|---|---|
| **Diameter** | 0.26 mm |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE[b,c]

| | |
|---|---|
| **Preanal length** | <50% SL preflexion, with development 50% SL |
| **Length at flexion** | |
| **Length at transformation** | |
| **Sequence of fin development** | Caudal, pectorals, anal, dorsal, pelvics |

**Pigment**

- Preflexion: Jaw tips, above brain and swimbladder, lateral cleithral
- Postflexion: Lower jaw, hindbrain, nape, double row of melanophores along dorsal midline beginning at midbody, series along anal fin base, caudal fin base, pelvic and anal fin, internal notochord pigment on trunk

**Diagnostic characters**

- Photophores: Br2, PO5, Vn, and PLO develop during larval period

Distinguished from other myctophids with round eyes by

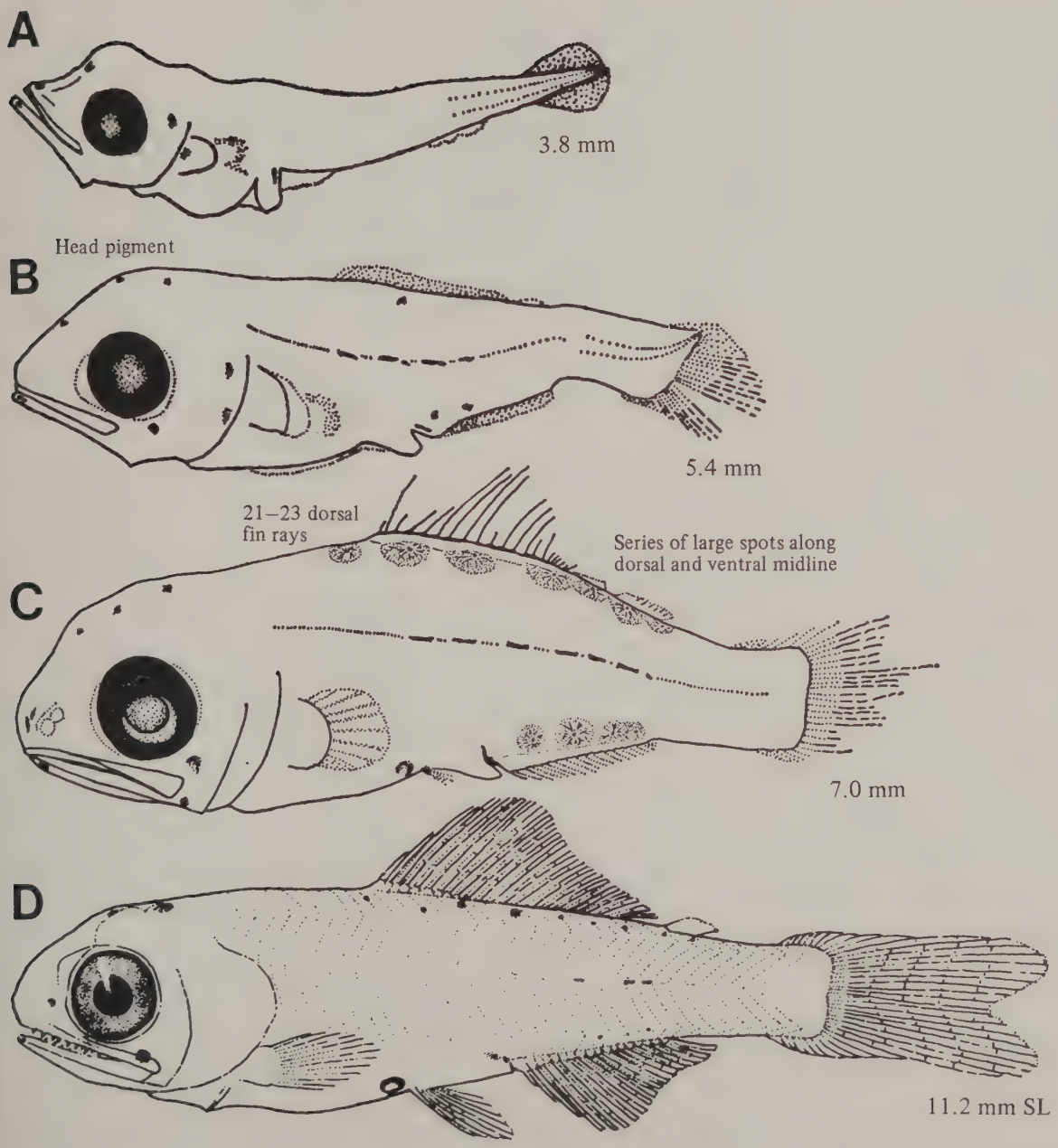
- Morphology: Body moderately deep, head and eyes large
- Midlateral and dorsal fin base pigment in postflexion larvae
- Highest dorsal fin ray count among myctophids in study area (21-23)
- Head pigment: Jaw tips, snout, opercle and brain

[a] According to Peden and Hughes (1986) northern records of *N. resplendens* are probably *N. japonicus*.

[b] H.G. Moser, NMFS Southwest Fish. Cent., P.O. Box 271, La Jolla, CA 92038, pers. commun., 9 Jan. 1984.

[c] Both *N. resplendens* and *N. japonicus* are described and illustrated in Ozawa (1986d). Specimens from the eastern Atlantic are figured here, but, according to Ozawa (1986d), they may differ in pigmentation and in photophore development from specimens found in the Pacific.

Ref: Badcock and Merrett 1976; Moser and Ahlstrom 1972; Ozawa 1986d; Moser, unpubl.




Figures A–C, Badcock and Merrett 1976 (eastern Atlantic specimens); D, Ahlstrom and Moser 1974.

## Gadiformes

Gadiform fishes include some of the most commercially important coldwater marine species in the world: the codfishes and their relatives. The order contains between 7 and 13 families, depending on the source, and well over 400 species. Fishes of this order are found worldwide and are generally bathypelagic (except for one freshwater species). Most species are elongate with some having long dorsal and/or anal fins. Pelvic fins are thoracic or jugular, and chin barbels are present in many. Although they are easily recognized and well studied, evolutionary relationships are poorly understood and most recent authors now propose a multiple origin for at least the Gadidae (Markle 1989). The early-life-history stages are well known, especially for the gadids and merlucciids, and have been studied for well over 100 years (Fahay and Markle 1984). Most eggs are pelagic, spherical, and have a single oil globule (lacking in some gadids). Larvae are commonly identified by their distinctive pigment patterns, coiled gut, and general tadpole shape. Morids, melanonids, and macrourids are less well known.

Families in study area: **Moridae**
**Melanonidae**
**Merlucciidae**
**Gadidae**
**Macrouridae**

Morids are benthopelagic fishes distributed throughout the world's oceans and are represented by two species in two genera in the study area. Very little is known of the early life history of the codlings. For the few species described, eggs are 0.52-1.16 mm in diameter, have one oil globule, and a smooth chorion (Fahay and Markle 1984). The scarcity of small fish in bottom trawls indicates the very young, and perhaps eggs, are pelagic (Iwamoto 1975). Most morids have precocious pelvic fin ray development. Usually the pelvic fin rays are elongate and probably undergo some ontogenetic reduction. Figures of larvae of *Physiculus nematopus* and *Laemonema* sp. are provided for comparison, since larvae of species in our area are unknown.

**Table 21**
**Meristic characters of family Moridae.**

| | | Vertebrae | | Fins | | | | | | Gill rakers | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Taxon | Distribution | Precaudal | Caudal (Total) | First Dorsal | Second Dorsal | Anal | Pectoral | Pelvic | Caudal (Total) | Upper | Lower | Branchiostegals |
| *Antimora** | | 24-25 | 33-35 (57-61) | 4-7 | 48-56 | 36-49 | 17-25 | 5-7 | | | | |
| *Antimora microlepis* | SSC - Bering Sea | 24-25 | 33 | 4-5 | 50-55 | 37-42 | 20 | 6-7 | 14,5+4,12 | 5 | 15 | 7 |
| *Laemonema** | | 15-17 | 42-45 (50-63) | 5-6 | 48-75 | 45-72 | 15-26 | 1-3 (usually 2) | | | | |
| *Laemonema longipes* | Bering Sea | | (51) | 6 | 50-52 | 45-50 | 15-17 | 2-3 | (22-25) | 5-7 | 19-20 | 6 |

*Data are from Fahay and Markle (1984).

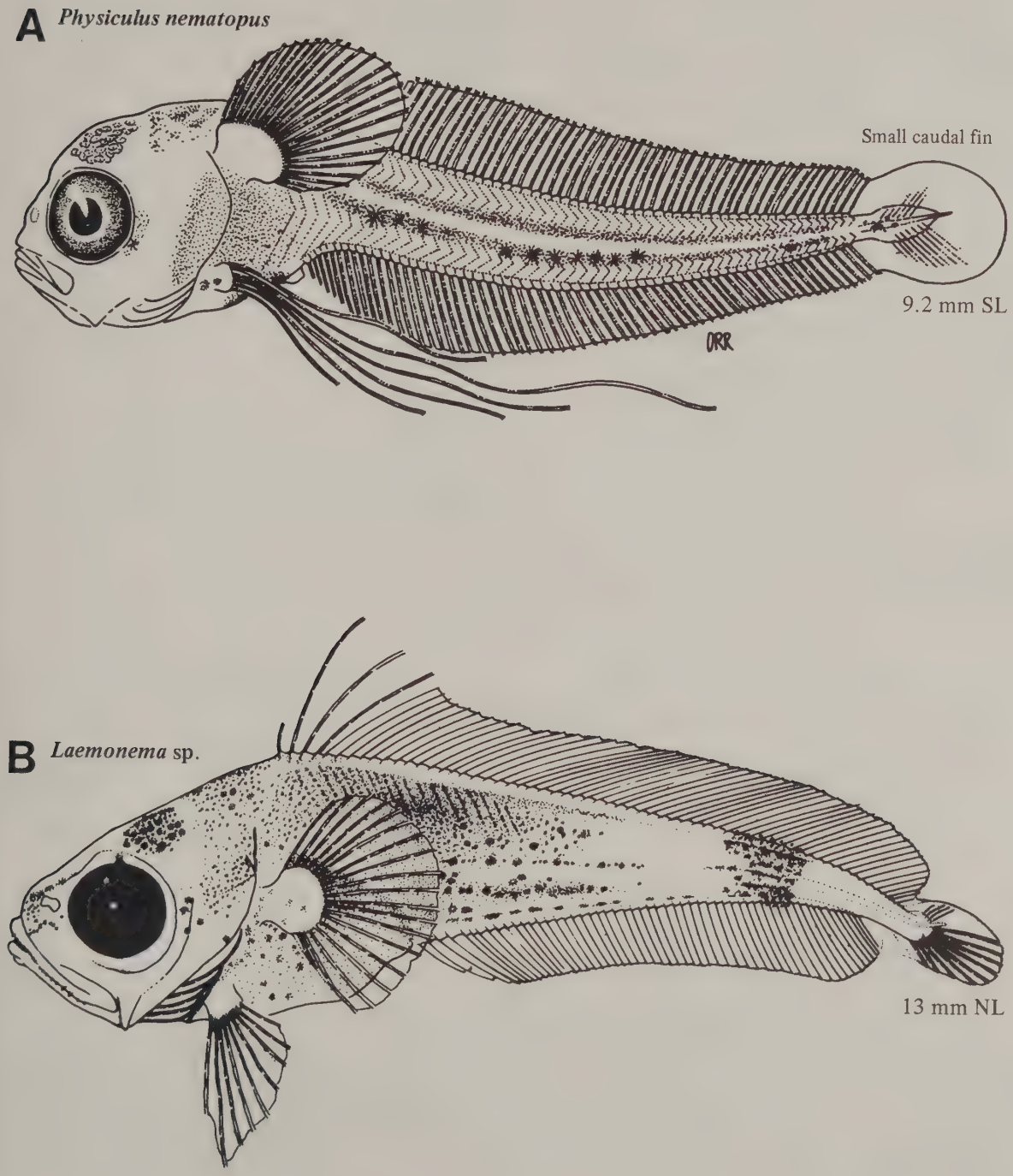



Figure A, Fahay and Markle 1984; B, Fahay 1983 (North Atlantic specimen; identification is tentative).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 58-X-62 |
| | Precaudal: 13-13-13 |
| | Caudal: 47-47-47 |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | 23-25, 6+3, 22-25 |
| **Pelvic fin** | Thoracic |
| | R: 5-X-7 |
| **Dorsal fin** | R: 67-X-80[a] |
| **Pectoral fin** | R: 12-X-16 |
| **Anal fin** | R: 52-X-61[a] |
| **Gill rakers** | U: 3-X-4 L: 6-X-11 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Brit. Col., 48°30′-55°N |
| **Ecology** | Mesopelagic, 200-1000 m |
| **ELH pattern** | Parity and eggs unknown, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE[b]

**Preanal length**
**Length at flexion**
**Length at transformation**
**Sequence of fin development**
**Pigment**

**Diagnostic characters**

- Large number of secondary caudal fin rays (23-25 upper and 22-25 lower)

[a] D. Markle, Dep. Fish. Wildl., Oregon State Univ., Corvallis, OR 97331-3803, pers. commun., 8 May 1986.
[b] Specimens <17 mm SL have not been identified.

Ref: Fahay and Markle 1984.

Figure A, NWAFC original (B. Vinter, Atlantic specimen); B, Fahay and Markle 1984 (South Atlantic specimen).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 52-53-55 |
| | Precaudal: 23-24-25 |
| | Caudal: 29-29-30 |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | 16-18, 6+2-3, 14-17 |
| **Pelvic fin** | Thoracic |
| | R: 6-X-8 |
| **Dorsal fin** | 1st: 10-11-13 2nd: 37-40-44 |
| **Pectoral fin** | R: 14-16-16 |
| **Anal fin** | R: 37-40-44 |
| **Gill rakers** | U: 4-X-5 L: 13-16-18 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Bering Sea, 54-66°N |
| **Ecology** | Epi- and mesopelagic, 0-914 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Jan-June[a] |
| | Area: Offshore pelagic;[b] 130-500 m[c] |
| | Mode: Schools[d] |
| | Migration: South and offshore to spawn (southern subpopulation); within Puget Sound and Straits of Georgia (northern subpopulation)[b] |
| **Fecundity** | Range/function: 3419[e]-496,000[f] |
| **Age at first maturity** | 2 yr[d]-4 yr[g] |
| **Longevity** | 17 yr[h] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.07-1.18 mm (1.12 mm) |
| **No. of oil globules** | One |
| **Oil globule diameter** | 0.27-0.34 mm |
| **Yolk** | May appear granular |
| **Envelope** | Clear, smooth |
| **Hatch size** | 2.4 mm NL |
| **Incubation time/temp.** | 3.1 d/16.6°C |

**Pigment**

- On yolk
- Characteristic late-stage patches on embryo

**Diagnostic characters**

- Pigment pattern
- Presence of oil globule
- Eye forms early during embryonic development

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | ~10 mm SL |
| **Length at transformation** | ~30-35 mm SL |
| **Sequence of fin development** | Caudal, pelvics, 1st dorsal, 2nd dorsal and anal, pectorals |

**Pigment**

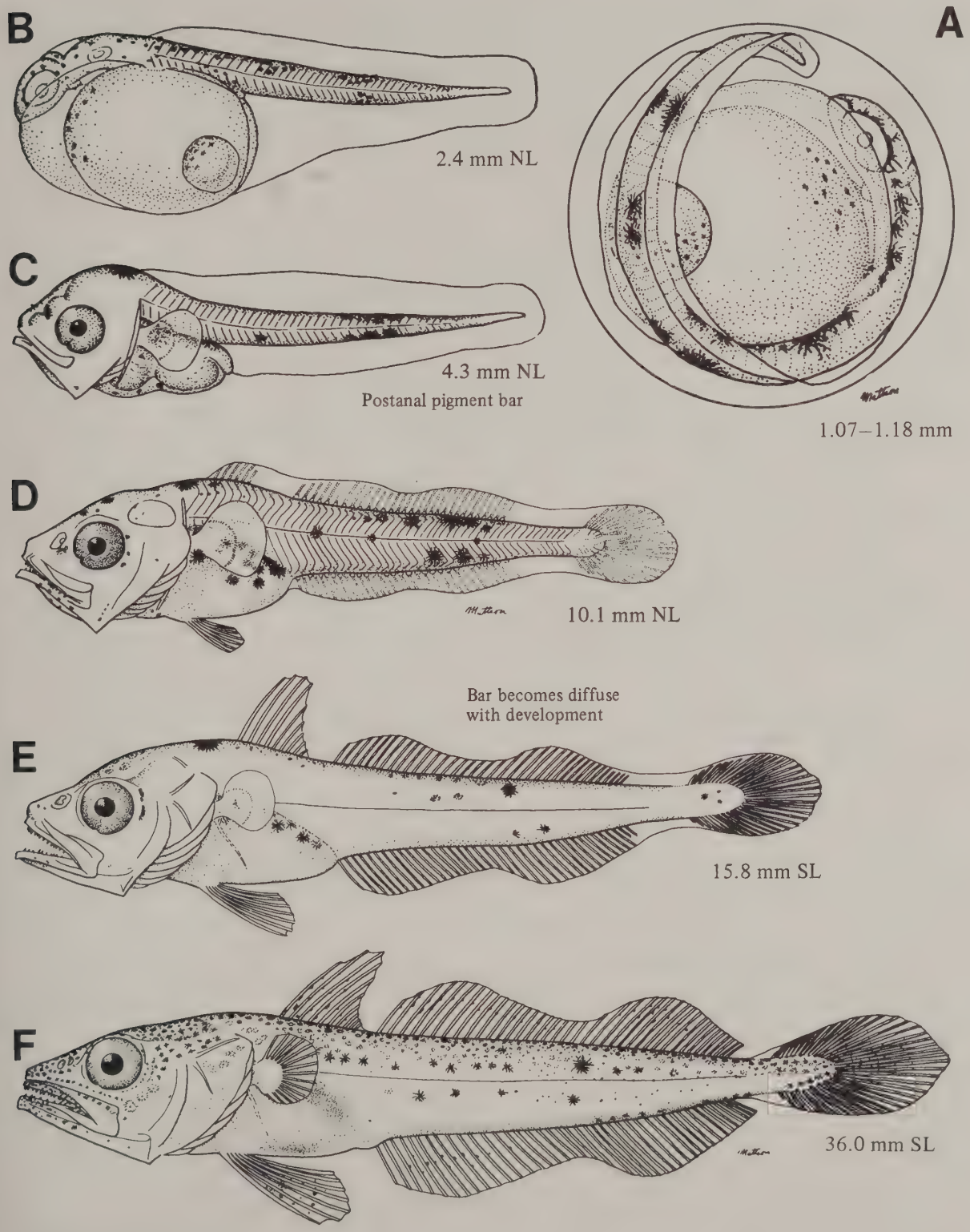
- Preflexion larvae: One postanal bar, one large dendritic spot several myomeres posterior to anus; with development, bar becomes diffuse, postanal body pigment increases, especially dorsolaterally
- On head, crown, and snout; increasing with development
- Dorsolaterally on gut

**Diagnostic characters**

- Gadoid shape but absence of >1 distinct postanal pigment bar
- Two dorsal fins and one anal fin
- Specimens from Puget Sound and Straits of Georgia have pigmented pectoral rays

[a] Hart 1973
[b] The main offshore population spawns offshore off southern California (Francis and Bailey 1983). Disjunct populations in the Puget Sound-Straits of Georgia area spawn in restricted areas within these regions.
[c] Bailey et al. 1982
[d] Kimura and Milliken 1977
[e] MacGregor 1971
[f] MacGregor 1966
[g] Best 1963
[h] Beamish 1979

Ref: Ahlstrom and Counts 1955, Fahay and Markle 1984.




Figures A–F, Ahlstrom and Counts 1955.

The family Gadidae is represented in the Northeast Pacific Ocean and Bering Sea by five species: Walleye pollock, *Theragra chalcogramma*; Pacific cod, *Gadus macrocephalus*; Pacific tomcod, *Microgadus proximus*; saffron cod, *Eleginus gracilis*; and Arctic cod, *Boreogadus saida*. Identification of gadid larvae prior to 1980 was not possible. Gadid larvae collected during ichthyoplankton studies were routinely reported as "Gadidae." Recent taxonomic studies have continued since 1980 and have allowed the specific identification of all five species in the area (e.g., Matarese et al. 1981 and Dunn and Vinter 1984). Identification is based primarily on differences in pigmentation patterns and meristic characters. The available knowledge of the general early life histories of these five species was recently reviewed by Dunn and Matarese (1987).

**Table 22**

**Characters useful in separating larvae of *Eleginus gracilis*, *Boreogadus saida*, *Gadus macrocephalus*, *Theragra chalcogramma*, and *Microgadus proximus* at specific size ranges (Dunn and Vinter 1984, in part).**

| Character | Size range (mm SL) | *E. gracilis* | *B. saida* | *G. macrocephalus* | *T. chalcogramma* | *M. proximus* |
|---|---|---|---|---|---|---|
| **Pigment** | | | | | | |
| Preanal region | | | | | | |
| Ventral gut | 4.4-13.5 | Double row of small melanophores | Absent in larvae <10mm; spots present anterior to pectoral fins in larvae >10 mm | Large melanophores medially | Relatively few scattered spots, more anterior than posterior | Large melanophores present, more anterior than posterior |
| Line of lateral pigment | 10-18 | Begins anterior to anus | Begins under second dorsal fin | Begins anterior to anus | Begins under second dorsal fin | Begins just anterior to anus |
| Postanal region | | | | | | |
| Length of ventral stripes (based on no. of melanophores) | 4-6 | Both longer than dorsal stripes | Both shorter than dorsal stripes | Anterior stripe longer than dorsal stripe (<5.3 mm) | Posterior stripe longer than dorsal stripe | Anterior stripe longer than dorsal stripe (<5 mm) |
| No. of myomeres from vertical end of anus to anterior end of first ventral pigment stripe | 4-6 | 4-6 | 5-7 | 1-3 (reaches vent by ~5.3 mm) | 4-5 | 1-3 (reaches vent by ~5.0 mm) |
| Length at which dorsal pigment forms a continuous line | 4-15 | ~10 mm | ~7 mm | ~5-6 mm | ~13 mm | ~13 mm |
| Length at which ventral pigment forms a continuous line | 4-10 | ~7 mm | ~10 mm | ~5-6 mm | Never merge | ~5-6 mm |
| On ventral margin of body | 10-15 | In double row on each side of midline | Pigment on midline and scattered on each side | Single row on each side of midline | Pigment on midline and a single row on each side | Single row on each side of midline anteriorly, single row on midline posteriorly |
| **Morphologic** | | | | | | |
| Position of vent relative to dorsal fins | 15-20 | Under second dorsal | Under second dorsal | Under second dorsal | Between first and second dorsal | Between first and and second dorsal (ultimately under first dorsal) |
| **Meristic** | | | | | | |
| No. of rays on superior hypural | >13 | 5 | 4 | 4 | 4 | 5 |

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 53-X-58<br>Precaudal: 18-X-20<br>Caudal: 35-X-39 |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | 21-25, 4+2, 21-25 |
| **Pelvic fin** | Thoracic<br>R: 6-6-6 |
| **Dorsal fin** | 1st: 10-X-17 2nd: 11-X-18<br>3rd: 16-X-24 |
| **Pectoral fin** | R: 18-X-19 |
| **Anal fin** | 1st: 13-X-21 2nd: 17-X-23 |
| **Gill rakers** | U: 8-X-9 L: 29-X-34 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Bering Sea, 54-66°N, to Arctic, not specific |
| **Ecology** | Epi- and mesopelagic, 0-731 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Oct-Mar[a]<br>Area: Nearshore[b]<br>Mode: Schools[b]<br>Migration: Nearshore to spawn[b] |
| **Fecundity** | Range/function: 9000-21,000[a] |
| **Age at first maturity** | 3 yr (females)[b]<br>2-3 yr (males)[b] |
| **Longevity** | 7 yr[b] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.53-1.90 mm |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous |
| **Envelope** | Smooth |
| **Hatch size** | 6 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | 11-17 mm SL |
| **Length at transformation** | 17-30 mm, pelagic until 30-45 mm SL |
| **Sequence of fin development** | Caudal, dorsals and anals, pectorals, pelvics |

**Pigment**

- Presence of bars
- Shorter ventral stripes
- Mediolateral pigment

**Diagnostic characters** (see Table 22)

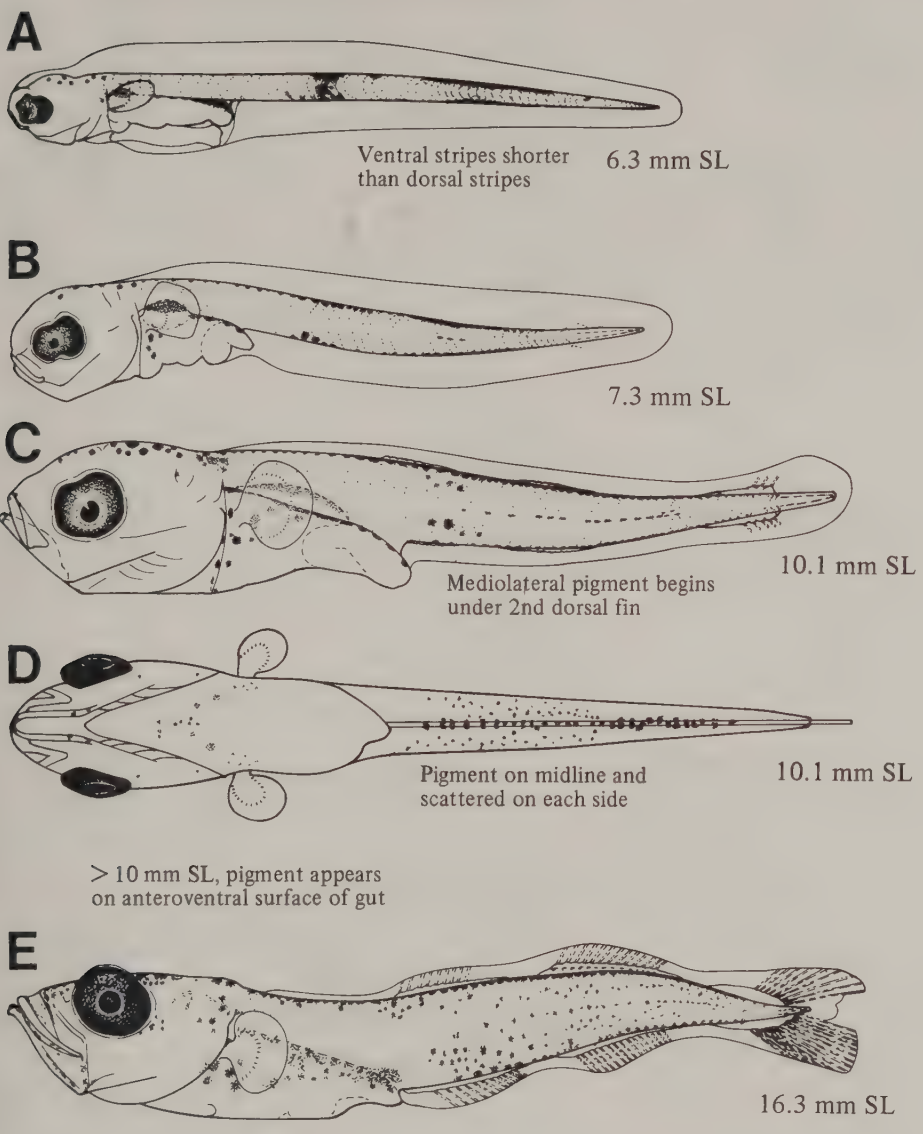
- Ventral pigment on midline and scattered on each side
- Rays on superior hypural = 4

Distinguished from *Theragra chalcogramma* by

- Ventral pigment on midline and scattered on each side. In *T. chalcogramma*, ventral pigment consists of a row along midline and a single row on each side.

[a] Bain and Sekerak 1978
[b] Craig et al. 1982

Ref: Dunn and Matarese 1984, Dunn and Vinter 1984.




Figures A–D (D, ventral view), Dunn and Vinter 1984; E, NWAFC original (B. Vinter).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 57-62-64<br>Precaudal: 21-X-24<br>Caudal: 37-X-41 |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | 22-25, 5+2, 23-26 |
| **Pelvic fin** | Thoracic<br>R: 6-6-6 |
| **Dorsal fin** | 1st: 11-X-16 2nd: 15-X-23<br>3rd: 18-X-21 |
| **Pectoral fin** | R: 18-X-21 |
| **Anal fin** | 1st: 20-X-24 2nd: 19-X-22 |
| **Gill rakers** | U: 2-X-3 L: 17-X-20 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Gulf of Alaska, 54-60°N, to Arctic, not specific |
| **Ecology** | Nearshore shelf pelagic, 2-75 m |
| **ELH pattern** | Oviparous, demersal eggs, pelagic larvae |
| **Spawning** | Season: Winter[a]<br>Area: Shallow nearshore (2-10 m)[a]<br>Mode:<br>Migration: To shallow water for spawning[a] |
| **Fecundity** | Range/function: 28,900-190,700[a] |
| **Age at first maturity** | 2 yr[a] |
| **Longevity** | 9 yr[a] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.0-1.7 mm (1.3-1.7 mm) |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous, dense |
| **Envelope** | Smooth, thick |
| **Hatch size** | 3.5 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | 11-17 mm SL |
| **Length at transformation** | 24-27 mm SL |
| **Sequence of fin development** | Caudal, dorsals and anals (nearly simultaneous), pelvics, pectorals |

**Pigment**

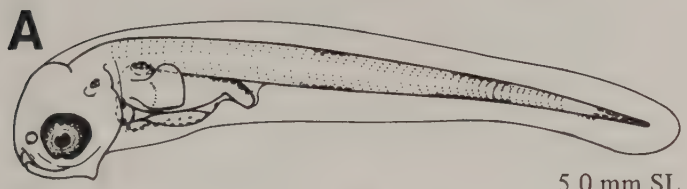
- Presence of bars
- Ventral stripes longer than dorsal stripes
- Ventral pigment in double row on each side of midline
- Mediolateral pigment begins anterior to anus
- Double row of melanophores along ventral surface of gut

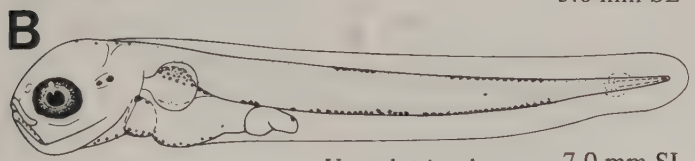
**Diagnostic characters** (see Table 22)

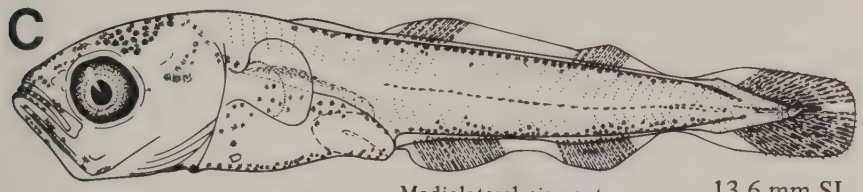
- Pigment
  - —Double row of melanophores along ventral surface of gut
  - —Double row of ventral pigment on each side of midline
- Rays on superior hypural = 5

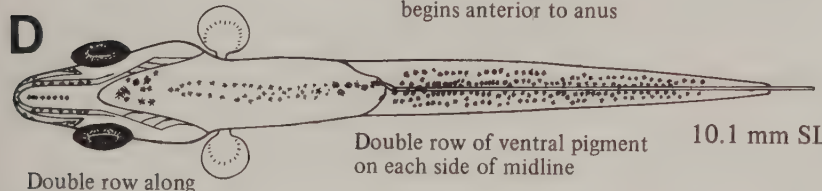
[a] Wolotira 1985

Ref: Dunn and Matarese 1984, Dunn and Vinter 1984.



Figures A–F (D, ventral view), Dunn and Vinter 1984.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 49-54-56<br>Precaudal: 18-X-21<br>Caudal: 31-X-35 |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | 23-24, 4+2, 21-22 |
| **Pelvic fin** | Thoracic<br>R: 6-X-7 |
| **Dorsal fin** | 1st: 10-12-16 2nd: 11-15-22<br>3rd: 10-X-21 |
| **Pectoral fin** | R: 19-20-22 |
| **Anal fin** | 1st: 16-18-27 2nd: 12-17-25 |
| **Gill rakers** | U: X-X-X L:X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Bering Sea, 54-66°N |
| **Ecology** | Epi-, meso-, and bathybenthal |
| **ELH pattern** | Oviparous, demersal eggs, pelagic larvae (small larvae demersal)[a] |
| **Spawning** | Season: Jan[b]-July[c]<br>Area: Semi-demersal (73-265 m)[c]<br>Mode: Schools[b]<br>Migration: To deepwater[d] |
| **Fecundity** | Range/function:<br>228,000[e]-3 million[f]/<br>$F = 12.024 \times L^{2.959}$ [g] |
| **Age at first maturity** | 2 yr[d] |
| **Longevity** | 13 yr[f] |

[a] Walters (1984) reported small larvae are demersal whereas Rugen and Matarese (1988) reported newly hatched larvae quickly rise to above 50 m.
[b] Miller et al. 1978
[c] Hirschberger and Smith 1983
[d] Ketchen 1961
[e] Thompson 1962
[f] Andriashev 1954
[g] Karp 1982

Ref: Dunn and Matarese 1984, 1987; Dunn and Vinter 1984; Matarese et al. 1981; Walters 1984.

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 0.98-1.08 mm (1.02 mm) |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous, dense |
| **Envelope** | Smooth, thick |
| **Hatch size** | 3-4 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | 10-17 mm SL |
| **Length at transformation** | 25-35 mm SL |
| **Sequence of fin development** | |

**Pigment**

- Presence of bars
- Ventral gut with large melanophores (in larvae >20 mm SL, small spots occur in two rows along ventral surface of gut)
- Stripe continuity (~5-6 mm SL)
- Mediolateral pigment begins anterior to anus (~5-6 mm SL)

**Diagnostic characters** (see Table 22)

- Pigment
  - —Large melanophores medially along length of gut
  - —Single irregular row of pigment on each side of ventral midline
  - —Ventral pigment begins at anus after yolksac absorption
- Rays on superior hypural = 4

Distinguished from *Theragra chalcogramma* at yolksac stage by

- Less lateral pigment within bars
- Posterior bar longer, extending closer to tail
- Presence of about 2-6 spots in the ventral caudal region
- More pigment in snout area and on mouth

Distinguished from *T. chalcogramma* at later stages by

- Generally more pigmented, especially on head and gut

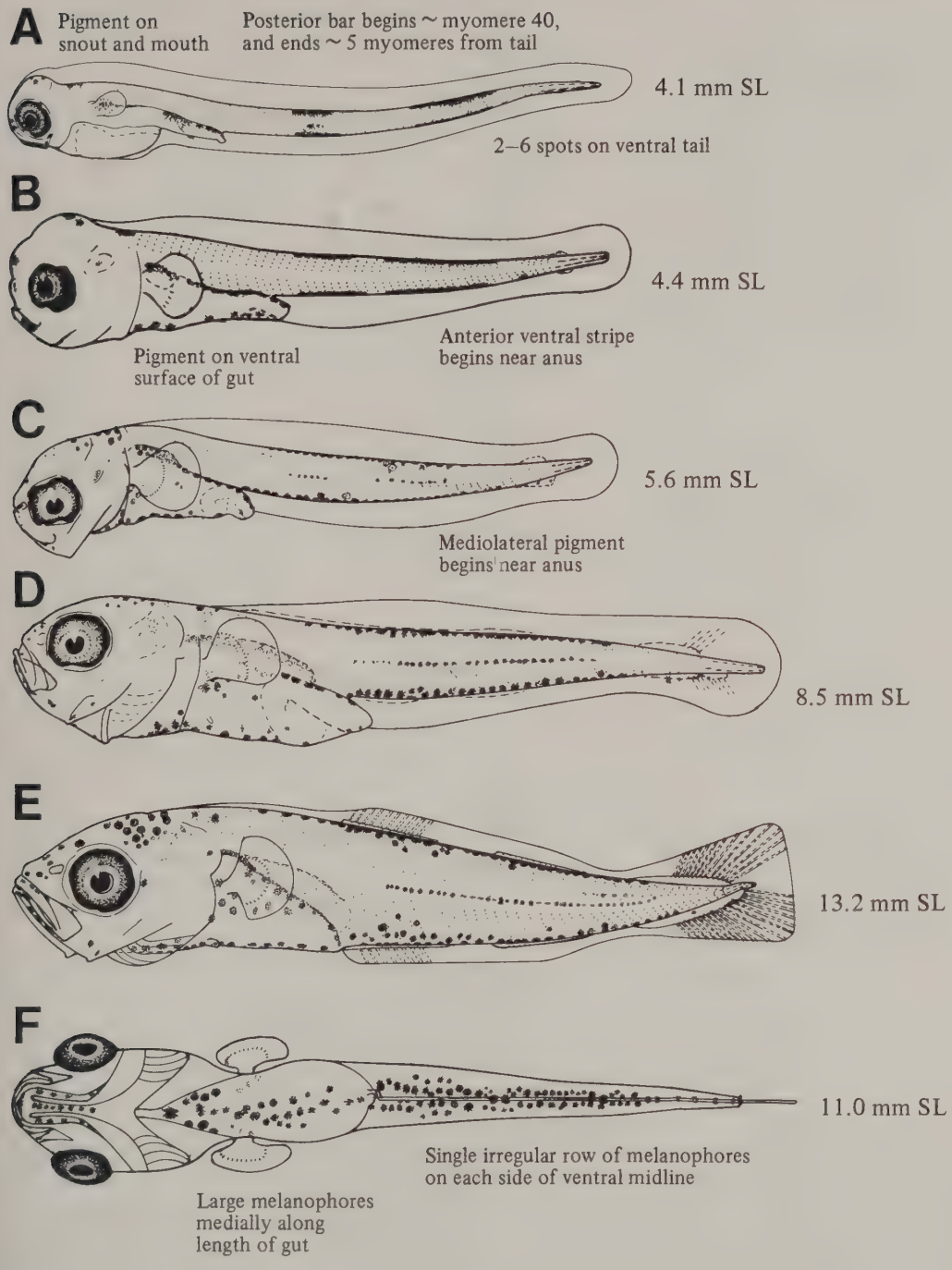

A
Pigment on snout and mouth
Posterior bar begins ~ myomere 40, and ends ~ 5 myomeres from tail
4.1 mm SL
2–6 spots on ventral tail
B
4.4 mm SL
Pigment on ventral surface of gut
Anterior ventral stripe begins near anus
C
5.6 mm SL
Mediolateral pigment begins near anus
D
8.5 mm SL
E
13.2 mm SL
F
11.0 mm SL
Single irregular row of melanophores on each side of ventral midline
Large melanophores medially along length of gut

Figure A, NWAFC original (B. Vinter); B, E–F (F, ventral view), Dunn and Vinter 1984; C–D, Matarese et al. 1981.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 53-56-60 | |
| | Precaudal: 17-20-21 | |
| | Caudal: 33-37-40 | |
| **Branchiostegal rays** | 6-X-8 | |
| **Caudal fin** | 22-26, 5+2, 20-24 | |
| **Pelvic fin** | Thoracic | |
| | R: 6-X-7 | |
| **Dorsal fin** | 1st: 9-X-15 | 2nd: 16-X-21 |
| | 3rd: 17-X-24 | |
| **Pectoral fin** | R: 19-19-19 | |
| **Anal fin** | 1st: 20-X-29 | 2nd: 18-X-28 |
| **Gill rakers** | U: 3-X-5 | L: 18-X-23 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Cent. California, 34-38°N, to Bering Sea, 54-66°N[a] |
| **Ecology** | Epi- and mesobenthal, 0-275 m |
| **ELH pattern** | Oviparous, demersal eggs, pelagic larvae |
| **Spawning** | Season: Winter-spring[b] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | |
| **No. of oil globules** | Probably none |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous |
| **Envelope** | |
| **Hatch size** | 3 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | 8-15 mm SL |
| **Length at transformation** | 22-28 mm, pelagic from 28-45 mm SL |
| **Sequence of fin development** | Caudal; 1st anal; 2nd anal; 3rd, 2nd, and 1st dorsal (nearly simultaneously); pelvics; pectorals |

**Pigment**

- Presence of bars
- Single row on each side of ventral midline anteriorly and a single row along ventral midline posteriorly
- Large melanophores scattered on ventral surface of gut

**Diagnostic characters** (see Table 22)

- Pigment
  - —Single row on each side of ventral midline anteriorly and a single row along ventral midline posteriorly
  - —Large melanophores scattered on ventral surface of gut
- Anterior placement of bars
- Rays on superior hypural = 5

Distinguished from *Gadus macrocephalus* by

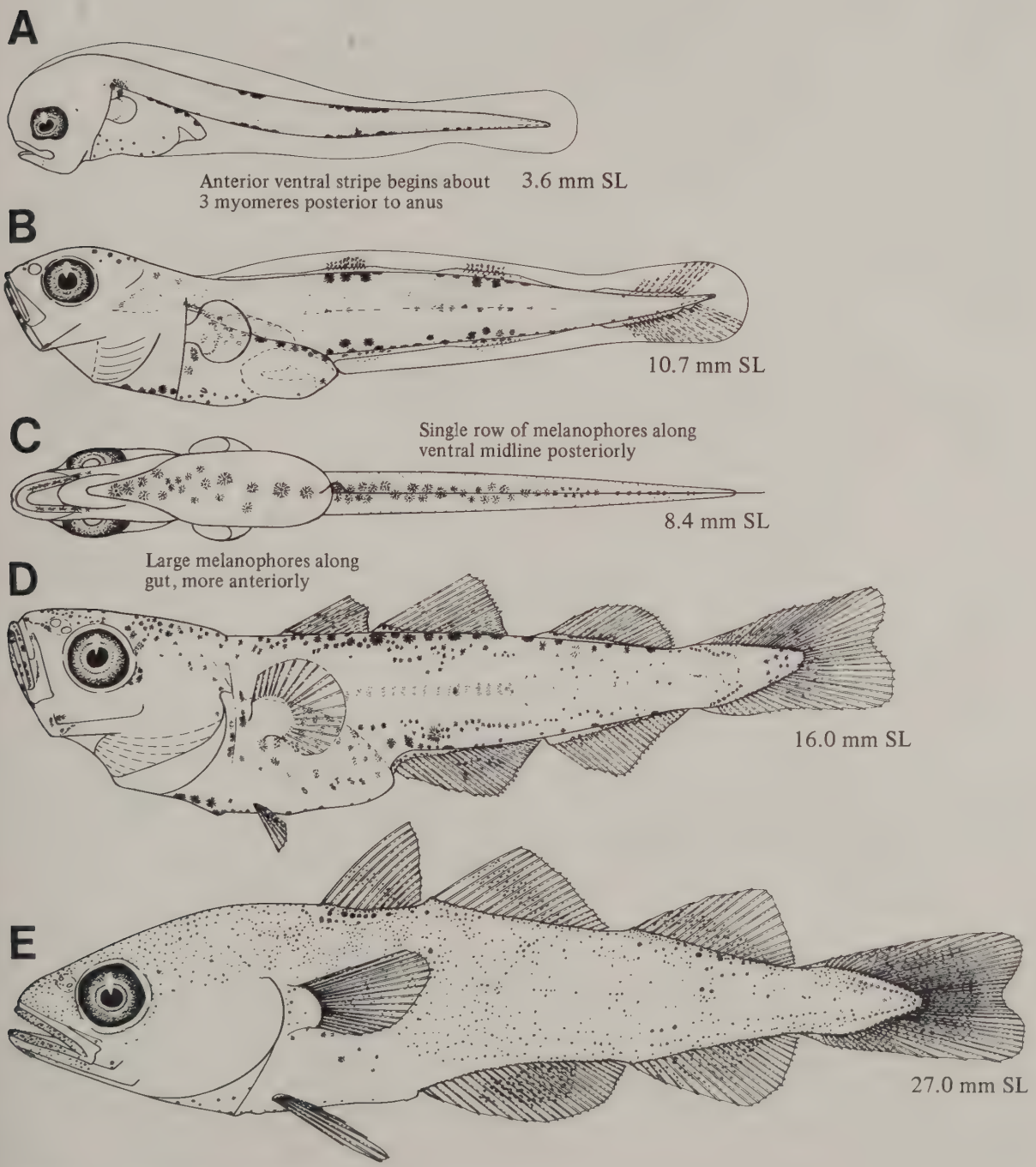
- Dorsal pigment separated in specimens <13 mm SL, bars not continuous

Distinguished from *Theragra chalcogramma* by

- Anterior bar begins closer to anus

[a] The presence of *M. proximus* larvae in the Bering Sea remains a question.
[b] Richardson 1977

Ref: Dunn and Vinter 1984, Matarese et al. 1981.




Figures A–E (C, ventral view), Matarese et al. 1981.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 48-51-53<br>Precaudal: 18-X-20<br>Caudal: 31-X-34 |
| **Branchiostegal rays** | 6-X-8 |
| **Caudal fin** | 21-24, 4+2, 19-22 |
| **Pelvic fin** | Thoracic<br>R: 6-X-7 |
| **Dorsal fin** | 1st: 10-12-14 2nd: 12-14-18<br>3rd: 14-17-21 |
| **Pectoral fin** | R: 17-20-22 |
| **Anal fin** | 1st: 15-18-22 2nd: 15-18-23 |
| **Gill rakers**[a] | U: 5-X-7 L: 25-X-34 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Cent. California, 34-38°N, to Chukchi Sea, north of 66°N |
| **Ecology** | Epi-, meso-, and bathypelagic, 0-975 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Feb-Aug[a]<br>Area: Pelagic (50-460 m)[a]<br>Mode: Schools[b]<br>Migration: Bering Sea, offshore to outer and upper slope;[c] Gulf of Alaska to Shelikof Strait[d] |
| **Fecundity** | Range/function:<br>91,633-1,200,000/<br>$F=0.1719\times L^{3.6046}$,<br>L=FL cm;[e]<br>96,216-1,079,540/<br>$F=1.2604\times L^{3.2169}$,<br>L=FL cm[f] |
| **Age at maturity** | 3-4 yr[g] |
| **Longevity** | 17 yr[g] |

[a] Hirschberger and Smith 1983
[b] Takahura 1954
[c] Serobaba 1968
[d] Dunn and Matarese 1987
[e] Hinckley 1986 (Bering Sea specimens only)
[f] Miller et al. 1986 (Shelikof Strait specimens only)
[g] Salveson and Alton 1976a

Ref: Dunn and Matarese 1984, 1987; Dunn and Vinter 1984.

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.35-1.45 mm (1.2-1.8) |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous |
| **Envelope** | Smooth, clear |
| **Hatch size** | 3-4 mm SL |
| **Incubation time/temp.** | 15 d/5°C |

**Pigment**
- Late-stage embryo develops bar pattern

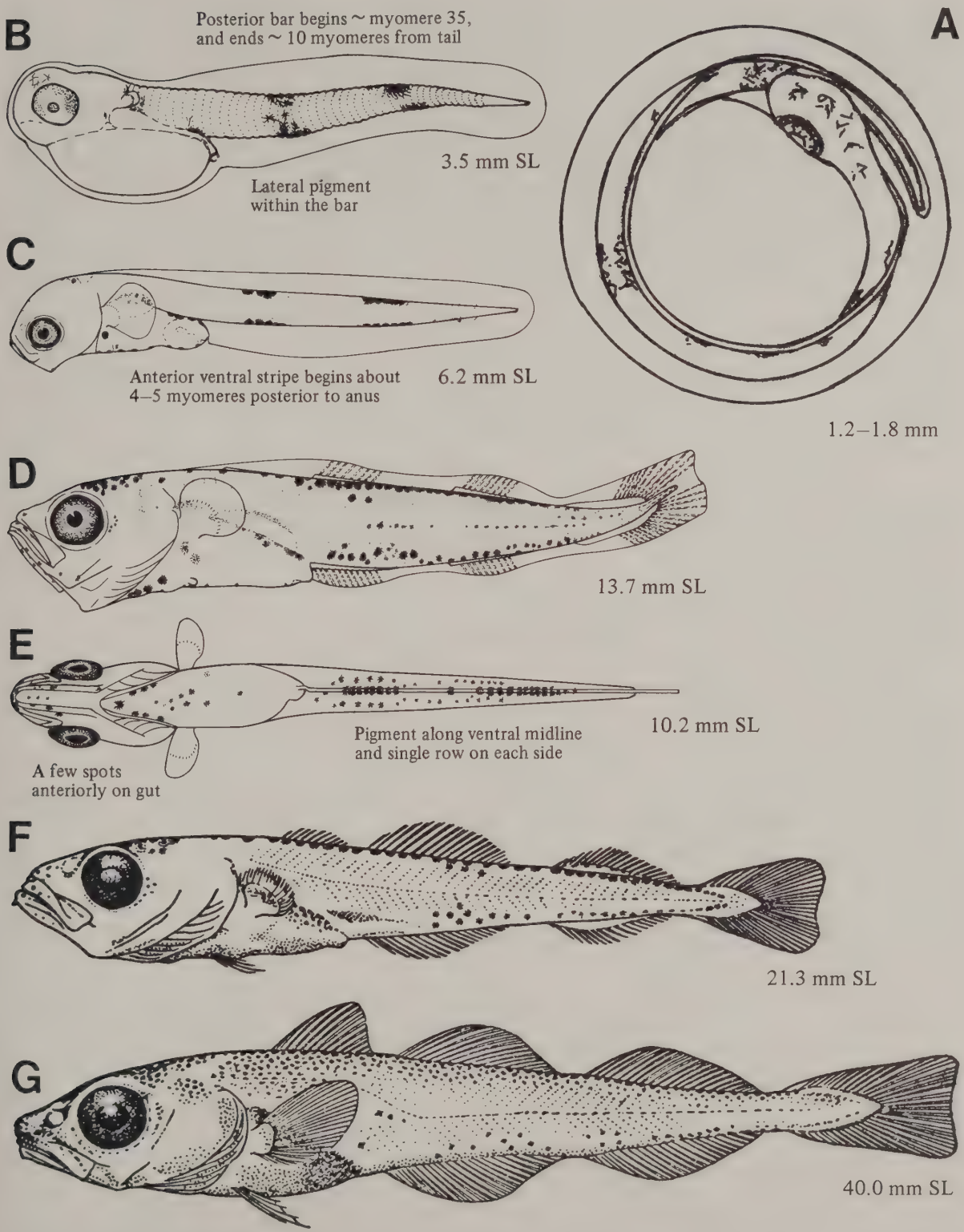
**Diagnostic characters**
- Late-stage embryo with pigment

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | 10-17 mm SL |
| **Length at transformation** | 30-40 mm SL |
| **Sequence of fin development** | Caudal, 1st anal, 2nd anal, 3rd dorsal, 2nd dorsal, 1st dorsal, pelvics, pectorals |

**Pigment**
- Presence of bars
- A few melanophores scattered on ventral surface of gut
- Pigment along ventral midline and a single row on each side

**Diagnostic characters** (see Table 22)
- See *Gadus macrocephalus* (p. 194)
- Pigment
  - —A few melanophores scattered on ventral surface of gut
  - —Pigment along ventral midline and a single row on each side
- Rays on superior hypural = 4




Figures A–B, NWAFC originals (B. Vinter); C–E (E, ventral view), Dunn and Vinter 1984; F–G, Gorbunova 1954.

Among the most common of all deep-sea bottom-living fishes, grenadiers are found in all the world's oceans. They have long, tapering bodies and elongate dorsal and anal fins continuous with the tail. A chin barbel is usually present. In the Northeast Pacific there are ten species in three genera. Adults have been found in water as shallow as 100 m but are more commonly collected at depths greater than 300 m (Fitch and Lavenberg 1968). Little is known of their early life history. Macrourid eggs are generally 1-2 mm, have a single oil globule, and some species have honeycomb ornamentation on the chorion. Larvae are characterized by an elongate tail, lack of caudal fin, and an elongate pectoral fin peduncle. The transition from larva to juvenile is rapid. The most important morphological change is the loss of the pectoral fin peduncle. Other morphological differences occurring at transformation include small changes in head length, mouth orientation changing from oblique to horizontal, snout becoming more distinct, and the stomach (gut) becoming reduced in prominence (decreasing depth of posterior trunk). The occurrence of juveniles of increasing size at increasing depth suggests an ontogenetic migration of subadults to a benthic existence (Stein 1980a). Some species remain pelagic throughout a prolonged juvenile period (Hubbs and Iwamoto 1977).

**Table 23**
**Meristic characters of family Macrouridae.**

| | | Vertebrae | | Fins | | | | | Gill rakers | |
|---|---|---|---|---|---|---|---|---|---|---|
| Taxon | Distribution | Precaudal (Total) | Caudal | First* Dorsal | Second Dorsal | Anal | Pectoral | Pelvic | Upper Lower (Total) | Branchiostegals |
| *Albatrossia pectoralis* | SSC - Bering Sea | 13-14 | | 9-11 | 126 | 131 | 16-21 | 6-8 | 5-7 (5-7) | 6 |
| *Coryphaenoides acrolepis* | SSC - Bering Sea | 13-16 | 70 | 10-13 | 138-153 | 123-135 | 19-22 | 7-9 | 5-7 (5-7) | 6 |
| *Coryphaenoides armatus* | SSC - Bering Sea | 13-15 | | 10-12 | | 77 | 18-22 | 10-12 | 1 6-9 (7-9) | 6 |
| *Coryphaenoides cinereus* | Oregon - Bering Sea | 13-14 | | 12-16 | | | 17-23 | 8-10 | 1 9-11 (9-12) | 6 |
| *Coryphaenoides filifer* | S. Calif. - Bering Sea | (84) | | 13-16 | | | 18-23 | 9-10 | (8-10) | 6 |
| *Coryphaenoides leptolepis* | SSC - SE Alaska | 12 | | 10-12 | | | 18-22 | 9-11 | 1 8-10 (8-11) | 6 |
| *Coryphaenoides liocephalus* | Brit. Col. | (84) | | 11 | 114 | 113 | 20 | 10 | | 6 |
| *Coryphaenoides longifilis* | Aleutian Is. - Bering Sea | 14-15 | | 14-16 | | | 15-19 | 9-10 | 2-3 12-13 | 6 |
| *Coryphaenoides yaquinae* | Cent. Calif. - Oregon | | | 9-12 | | | 16-22 | 8-11 | (11-12) | |
| *Nezumia stelgidolepis* | SSC - Brit. Col. | 13 | 73-77 | 10-13 | | | 20-26 | 8-11 | (8-12) | 7 |

*First dorsal fin count includes two spinous rays.

**Table 24**

**Morphological characters useful in identifying macrourid larvae likely to occur off the coast of Oregon (Stein 1980a).**

| | *Albatrossia pectoralis* | *Coryphaenoides* | | | | |
|---|---|---|---|---|---|---|
| | | *C. acrolepis* | *C. armatus* | *C. cinereus* | *C. filifer* | *C. leptolepis* |
| Larval body pigment | Unknown | Melanophores on dorsum and venter, absent on last 20% of tail and on midline | Unknown | Unknown | Melanophores widely scattered on dorsum around dorsal fin only | Melanophores on trunk and head, closely spaced, not posterior to anal fin ~10th ray |
| First dorsal fin rays | 7-9 | 9.11 | 8-10 | 10-12 | 11-15 | 8-10 |
| Pelvic fin rays | 6-8 | 8-9 | 10-11 | 8-10 | 9-10 | 9-10 |
| Pyloric caeca | 12-16 | 12-14 | 10-13 | 5-7 | 8-12 | 11 |
| Rostral scutes[a] | Absent | Strong | Absent | Strong | Strong | Absent |
| Size at which pectoral fin peduncle is reduced | — | 9.4-9.8 mm HL[b] | 18.2 mm HL | — | 14.1-14.6 mm HL | 6.2-15.0 mm HL |
| Precaudal vertebrae | 13-14 | 14-15 | 13-15 | 13-14 | — | 12 |
| Gas glands[a,c] | 2 | 4 | 5-6 | 4 | 4 | 6 |
| Retia[a,c] | 2 | 4 | 5-6 | 4 | 4 | 6 |

[a] Adult/juvenile characters.
[b] Since macrourid larvae often have damaged tails, body lengths are generally described by head lengths (HL).
[c] The swimbladder in postlarvae and juveniles can be examined by making an incision in the side of the abdominal cavity.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 86-86-86 |
| | Precaudal: 14-X-15 |
| | Caudal: 70-70-70 |
| **Branchiostegal rays** | 6-6-6 |
| **Caudal fin** | Absent |
| **Pelvic fin** | Thoracic |
| | R: 8-X-9 |
| **Dorsal fin**[a] | 1st: 9-X-11 2nd: 138-X-153 |
| **Pectoral fin** | R: 19-20-22 |
| **Anal fin** | R: 123-X-135 |
| **Gill rakers** | U: X-X-X L: 5-6-7 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Bering Sea, 54-66°N |
| **Ecology** | Meso- and bathybenthal |
| **ELH pattern** | Oviparous, eggs probably pelagic, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | Ripe eggs 2 mm |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

**Preanal length**
**Length at flexion**
**Length at transformation**
**Sequence of fin development**
**Pigment**

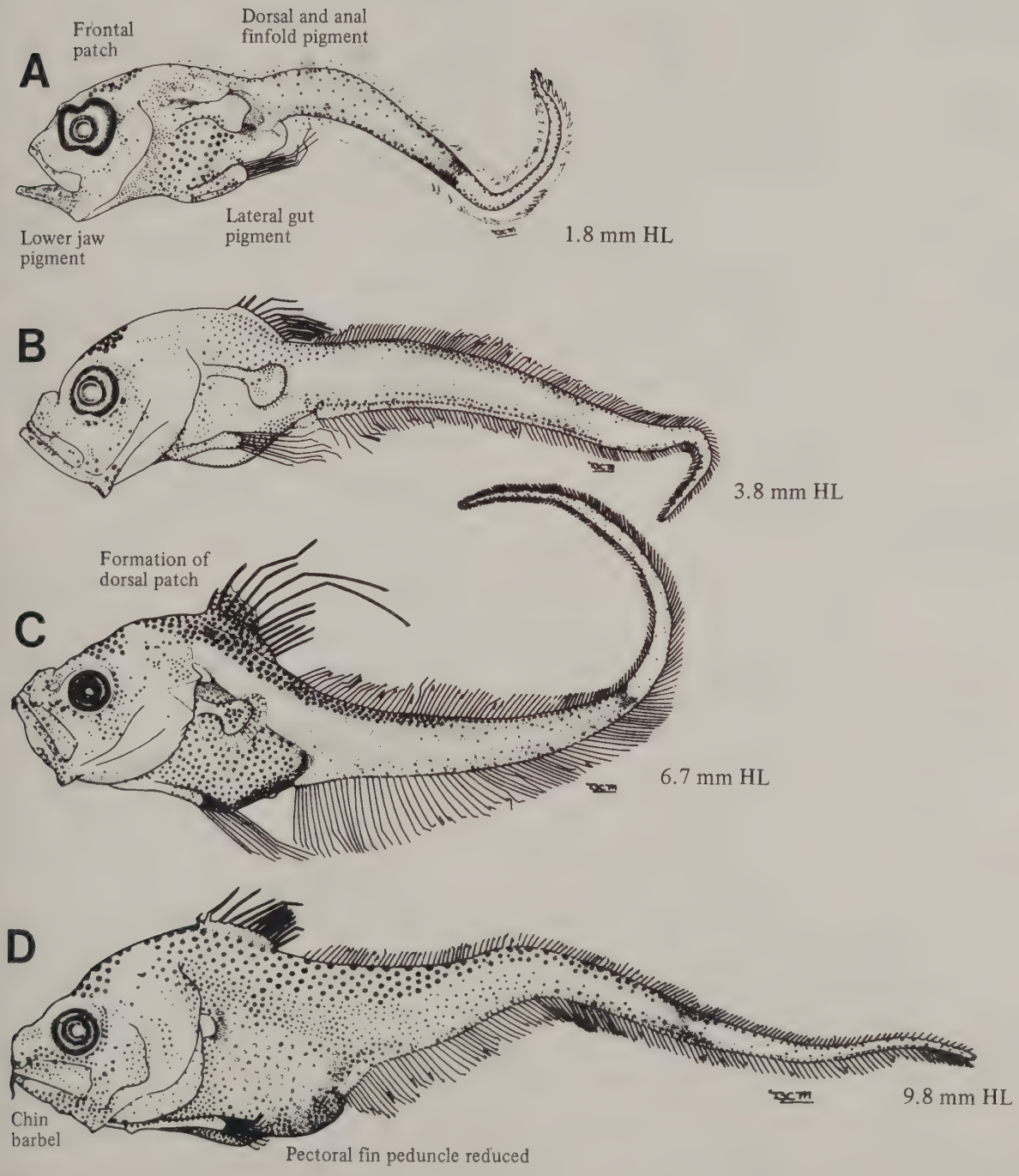
- Melanophores on dorsal and ventral body surface
- Lateral pigment absent on posterior 20% of body

**Diagnostic characters** (see Table 24)

- Number of first dorsal fin rays (9-11)
- Pelvic fin rays (8-9)
- Number of gas glands (four)
- Presence of rostral scutes in juveniles >16 mm HL

[a] Range of counts for the first dorsal does not include "spines."

Ref: Stein 1980a.




Figures A–D, Stein 1980.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 84-84-84 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 6-6-6 |
| **Caudal fin** | Absent |
| **Pelvic fin** | Thoracic |
| | R: 9-9-10 |
| **Dorsal fin**[a] | 1st: 11-X-15 2nd: X-X-X |
| **Pectoral fin** | R: 18-22-23 |
| **Anal fin** | R: X-X-X |
| **Gill rakers** | U: X-X-X L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Bering Sea, 54-66°N |
| **Ecology** | Bathybenthal |
| **ELH pattern** | Oviparous, eggs probably pelagic, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

**Preanal length**
**Length at flexion**
**Length at transformation**
**Sequence of fin development**
**Pigment**

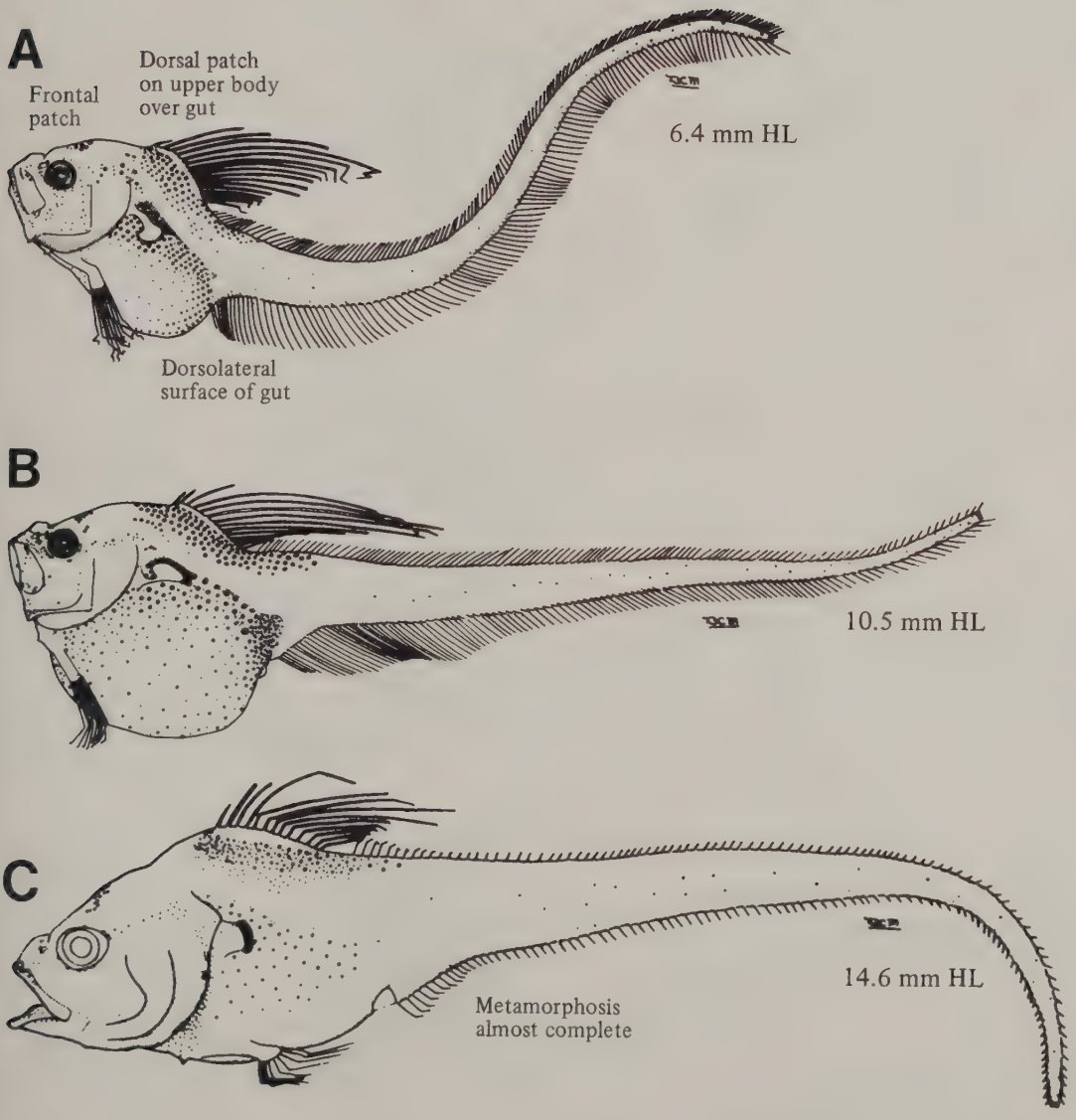
- Melanophores widely scattered on upper dorsal body around dorsal fin

**Diagnostic characters** (see Table 24)

- Number of first dorsal fin rays (11-15)
- Pelvic fin rays (9-10)
- Number of gas glands (four)
- Pigment pattern: Fine pigment spots under first dorsal fin

[a] Range of counts for the first dorsal does not include "spines."

Ref: Stein 1980a.




Figures A–C, Stein 1980. Figure C is a composite drawn from two specimens. The head has been reconstructed.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: X-X-X |
| | Precaudal: 12-12-12 |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 6-6-6 |
| **Caudal fin** | Absent |
| **Pelvic fin** | Thoracic |
| | R: 9-X-10 |
| **Dorsal fin**[a] | 1st: 8-X-10 2nd: X-X-X |
| **Pectoral fin** | R: 18-19-22 |
| **Anal fin** | R: X-X-X |
| **Gill rakers** | U: 1-1-1 L: 8-X-10 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to SE Alaska, 55-59°N |
| **Ecology** | Bathybenthal |
| **ELH pattern** | Oviparous, eggs probably pelagic, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

**Preanal length**
**Length at flexion**
**Length at transformation**
**Sequence of fin development**
**Pigment**

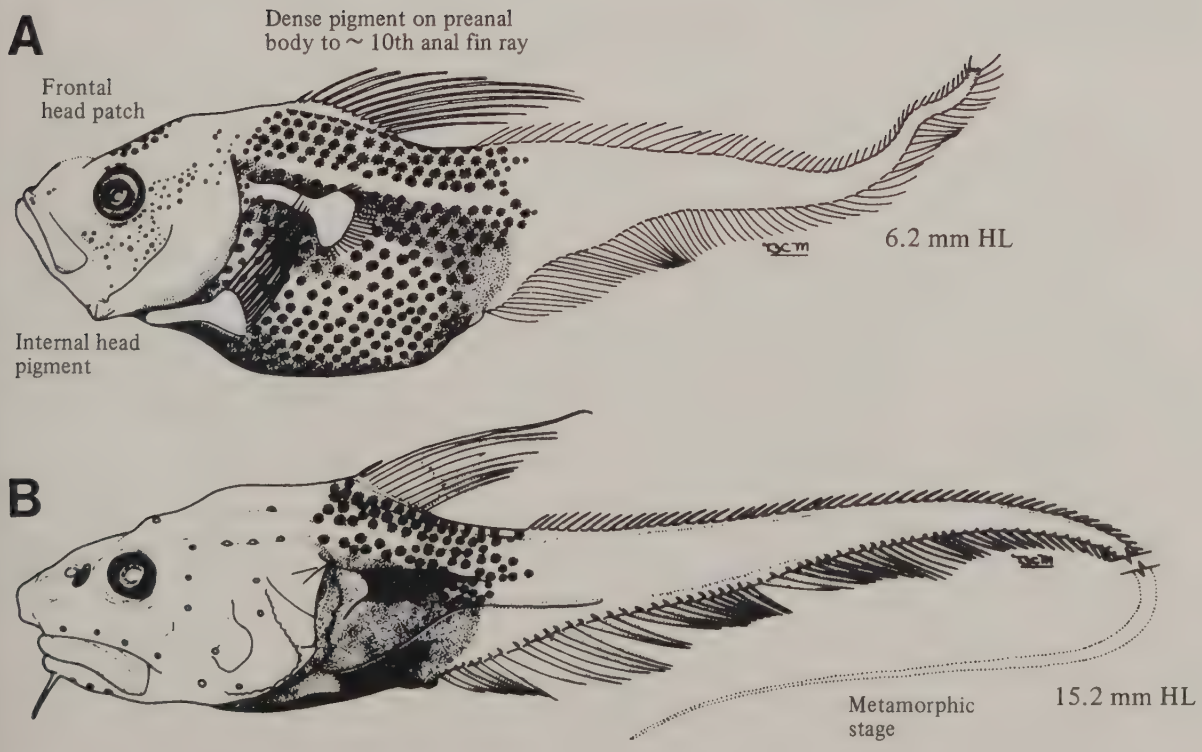
- Melanophores on trunk, gut, and head dense, but not present posterior to anal fin (~10th ray)[b]

**Diagnostic characters** (see Table 24)

- Pigment pattern: Pigment to 10th anal fin ray
- Number of gas glands (six)
- Number of first dorsal fin rays (8-10)

[a] Range of counts for the first dorsal does not include "spines."
[b] According to Stein (1980a), this pattern may be similar in *C. armatus*.

Ref: Stein 1980a.




Figures A–B, Stein 1980.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 86-X-90 |
| | Precaudal: 13-13-13 |
| | Caudal: 73-X-77 |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | Absent |
| **Pelvic fin** | Thoracic |
| | R: 8-X-11 |
| **Dorsal fin** | S: 10-X-13 R: X-X-X |
| **Pectoral fin** | R: 20-X-26 |
| **Anal fin** | R: X-X-X |
| **Gill rakers** | U: X-X-X L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Brit. Col., 48°30′-55°N |
| **Ecology** | Epi- and mesobenthal |
| **ELH pattern** | Oviparous, eggs unknown, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE - Genus

**Preanal length** <30% SL
**Length at flexion**
**Length at transformation**
**Sequence of fin development**
**Pigment**

- Frontal patch
- First dorsal fin patch
- Heavy over entire gut
- Ventral midline series and double lateral spots approximately first half of postanal body

**Diagnostic characters**

- Lateral pigment on postanal body appears to be distinctive perhaps at generic level, but whether it appears in other macrourine larvae cannot be determined at this time

Ref: Fahay and Markle 1984.

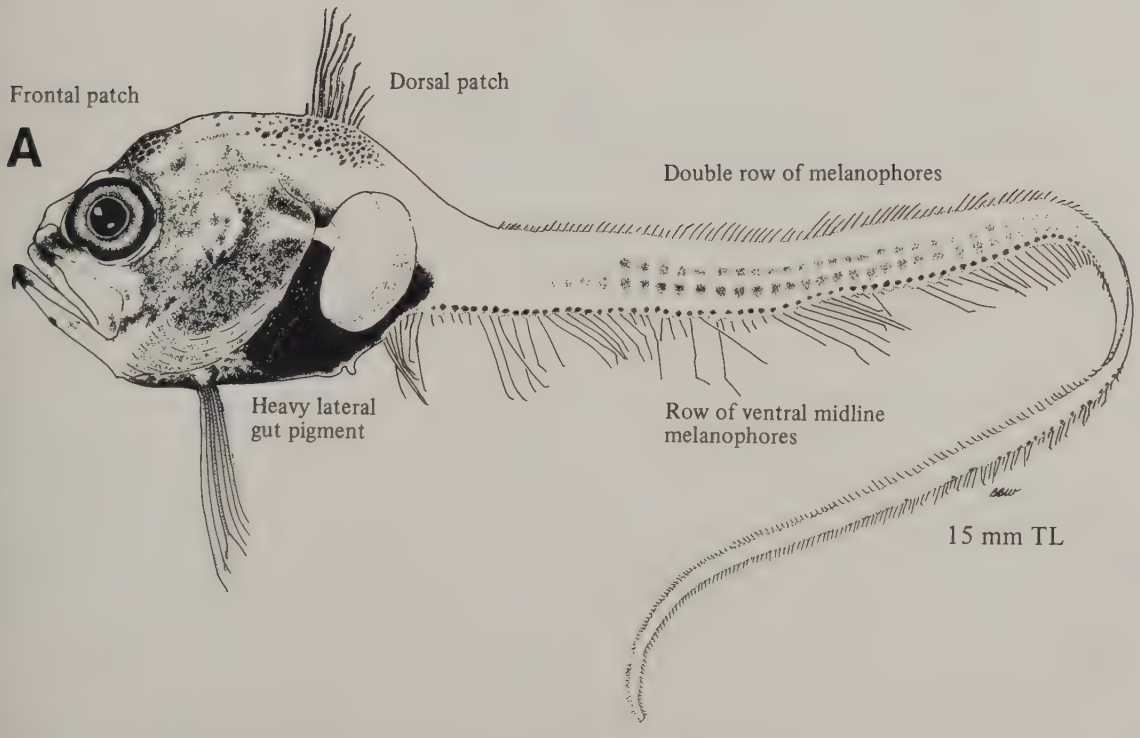
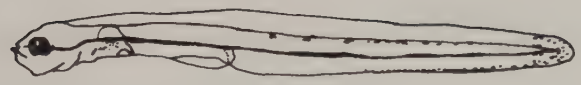



Figure A, Fahay and Markle 1984. North Atlantic specimen tentatively identified as *Nezumia*.



## Ophidiiformes

The ophidiiforms occupy mostly benthic habitats ranging from the shallow tropics to abyssal depths and subarctic locations. Adults have long tapering bodies, with or without a caudal fin, and long dorsal and anal fins. The order comprises 4 families, 86 genera, and 294 species (J. Nelson 1984). The two suborders are defined according to mode of reproduction: Ophidioidei (Ophidiidae) are oviparous and Bythitoidei (Aphyonidae and Bythitidae) are viviparous (Cohen and Nielsen 1978). Ophidiiform eggs of oviparous forms are pelagic, may have one oil globule, and are spherical or ellipsoidal (Gordon et al. 1984). Larvae are not well known; of the eight species found in the study area only two larval series have been identified and are presented here. A third series of an unidentified ophidiid has been tentatively identified as *Spectrunculus grandis*.

Families in study area: **Ophidiidae**
**Aphyonidae**
**Bythitidae**

Fishes of this group are found primarily in tropical and temperate waters, although a few occur in subarctic locations. In the northeastern Pacific there are six species within five genera in the family. Larvae are known only for *Chilara taylori*, but a second series has been tentatively identified as *Spectrunculus grandis*. These larvae occur in samples collected off northern California, Oregon, and Washington. Since meristic characters, especially vertebral counts, are unavailable for several species in the area, only a tentative identification can be made. Available meristics, however, match those of *Spectrunculus grandis*. These larvae resemble those of the pleuronectid, *Embassichthys bathybius*, and have been routinely mixed with them in samples. They can be distinguished from *E. bathybius* (p. 580) larvae by number of myomeres (>75 vs. 65), less finfold pigment, and a less pronounced loop in the gut.

**Table 25**
**Meristic characters of family Ophidiidae.**

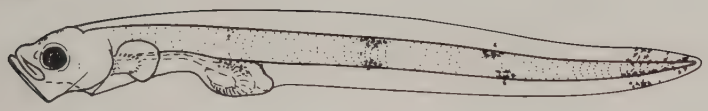
| | | Vertebrae | | Fins | | | | Gill rakers | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Taxon | Distribution | Precaudal | Caudal | Dorsal | Anal | Pectoral | Pelvic | Upper | Lower | Branchiostegals |
| *Bassozetus* sp. | Oregon | | | | | | | | | |
| *Chilara taylori* | SSC - Oregon | 18-19 | 68-72 | 198-216 | 156-170 | | I,1 | 1-4 | 5-9 | 7 |
| *Dicrolene filamentosa* | SSC - Oregon | | | 100-104 | 84-90 | 23-29 | I,2 | 5 | 17 | 8 |
| *Holcomycteronus profundissimus* | Oregon | 18-21 | | 107-118 | 80-95 | 15-17 | I,2 | | | 8 |
| *Spectrunculus grandis** | Cent. Calif. - Gulf of Alaska | 23 | 56 | 103-140 | 73-106 | 26-30 | I,2 | 3-4 | 8-9 | 8 |
| *Spectrunculus radcliffei* | Gulf of Alaska | | | | | | | | | |

*Aboussouan and Rasonarivo (1986) described a larva as *S. grandis* from the Indian Ocean. The counts are the following:

| | |
|---|---|
| precaudal vertebrae | 18-19 |
| caudal vertebrae | 53 |
| dorsal fin | 118 |
| anal fin | 96 |
| pectoral fin | 23/24 |
| pelvic fin | I,2 |
| caudal fin | 4+4/5 |

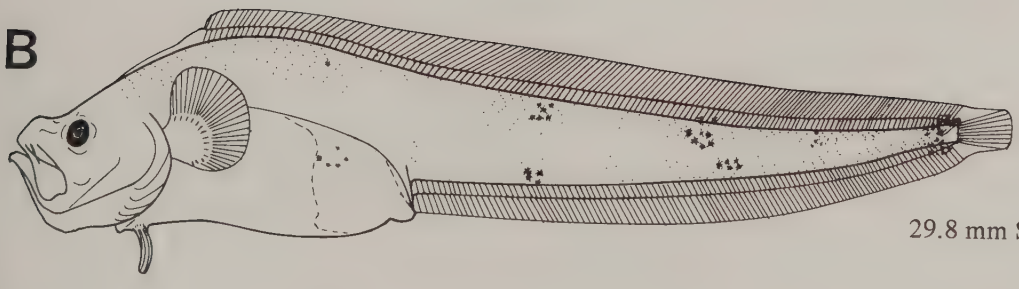
Ophidiidae (tentatively *Spectrunculus grandis*)

A



15.6 mm SL

B



29.8 mm SL

Figures A–B, NWAFC originals (B. Vinter).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 86-88-91 |
| | Precaudal: 18-18-19 |
| | Caudal: 68-70-72 |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | X, 4+5, X |
| **Pelvic fin** | Jugular |
| | S: 1-1-1 R: 1-1-1 |
| **Dorsal fin** | R: 198-X-216 |
| **Pectoral fin** | R: 22-X-25 |
| **Anal fin** | R: 156-X-170 |
| **Gill rakers** | U: 1-X-4 L: 5-X-9 |

## LIFE HISTORY

| | |
|---|---|
| **Range**[a] | South of southern California to Oregon, 42-46°N |
| **Ecology** | Epi- and mesobenthal, 1-244 m |
| **ELH pattern** | Oviparous, eggs unknown, pelagic larvae |
| **Spawning** | Season: Larvae collected in fall (Baja California)[b] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

**Preanal length** <50% SL
**Length at flexion**
**Length at transformation** 22-30 mm SL
**Sequence of fin development**
**Pigment**

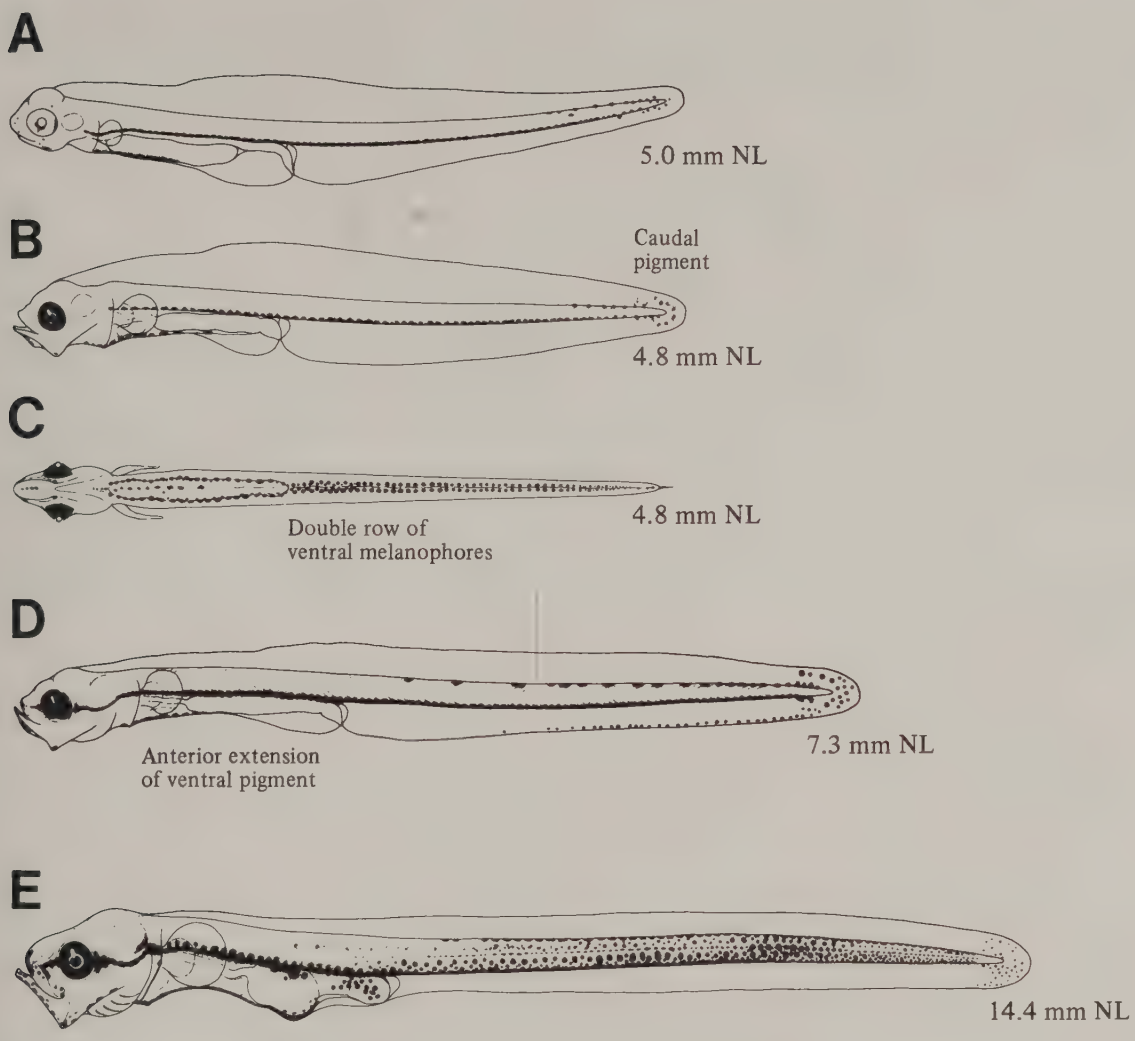
- Caudal fin pigment
- Ventral (double series) with development, extends along base of brain and onto snout
- Ventral gut

**Diagnostic characters**

- Gut loops form at 14 mm SL
- Distinctive pigment pattern
- High number of myomeres (86-91)

[a]Center of distribution is Pt. Eugenia, Baja California.
[b]Ambrose et al. 1983

Ref: Ambrose et al. 1983.




Figures A–E (C, ventral view), Ambrose et al. 1983.

NOAA, National Marine Fisheries Service

Fishes of this group are found in tropical and temperate waters, freshwater, and at abyssal depths. The families Aphyonidae and Bythitidae, which form the suborder, are represented in the Northeast Pacific by four species within four genera. Only larvae of *Brosmophycis marginata* are known. All bythitoid males possess an intromittent organ, some with pseudoclaspers.

**Table 26**
**Meristic characters of suborder Bythitoidei.**

| Taxon | Distribution | Vertebrae | | Fins | | | | Gill rakers | | Branchiostegals |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Precaudal (Total) | Caudal | Dorsal | Anal | Pectoral | Pelvic | Upper (Total) | Lower | |
| **Aphyonidae** | | | | | | | | | | |
| *Barathronus pacificus* | N. Calif. - Oregon | 37-38 | 46-51 | 71-75 | 62-69 | 25-26 | I,1 | 5-7 | 26-28 | |
| *Sciadonus pedicellaris* | SSC - Oregon | 43-47 | 36-39 | 91-93 | 42-47 | 11-14 | I,1 | (14-15) | | 9-10 |
| **Bythitidae** | | | | | | | | | | |
| *Brosmophycis marginata* | SSC - SE Alaska | 16-17 | 47-49 | 99-110 | 72-81 | 20-26 | I,2 | | | 7 |
| *Cataetyx rubrirostris* | S. Calif. - Oregon | (60-62) | | 102-109 | 76-82 | | I,1 | 3 | | 8 |

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 63-64-65 |
| | Precaudal: 16-16-17 |
| | Caudal: 47-48-49 |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | |
| **Pelvic fin** | Jugular |
| | S: 1-1-1 R: 2-2-2 |
| **Dorsal fin** | R: 99-101-110 |
| **Pectoral fin** | R: 20-X-26 |
| **Anal fin** | R: 72-75-81 |
| **Gill rakers** | U: X-X-X L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to SE Alaska, 55-59°N |
| **Ecology** | Epi- and mesobenthal, 3-256 m |
| **ELH pattern** | Probably ovoviviparous, pelagic larvae |
| **Spawning** | Season: Spring[a] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: 12,000-30,000[a] |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | 9.0 mm NL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE[b]

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | >13.5-18.0 mm SL |
| **Length at transformation** | |
| **Sequence of fin development** | |

**Pigment**

- Newly hatched larvae have pigment on lower jaw
- Alternating dorsal/ventral spots
- Above/below anterior portion of tail tip (more pronounced in specimens <12.5 mm SL)
- Swimbladder and on gut

**Diagnostic characters**

- Pigment pattern: Dorsal/ventral spots

[a] Hart 1973

[b] A figure of a postflexion bythitid from the Atlantic Ocean is included for comparison.

Ref: NWAFC, unpubl.

10.6 mm SL

Alternating dorsal and ventral spots

12.5 mm NL

21.9 mm SL

**(Unidentified bythitid)**

Figure A, NWAFC original (B. Vinter); B–C, Gordon et al. 1984 (C, North Atlantic specimen).

## Lophiiformes

The order Lophiiformes includes some of the most unusual fishes known. Adults exhibit several forms: Dorsoventrally flattened and ventrally compressed forms found in shallow-water benthic habitat, and globose, flabby-bodied forms found at meso- and bathypelagic depths. Worldwide there are 18 families, 63 genera, and 262 species (Pietsch 1984). All families are characterized by having a luring apparatus (illicium) bearing a terminal bait (esca) originating from three modified anterior dorsal spines and a narrow tube-like gill opening located near the pectoral fin. Extreme sexual dimorphism is common among the fishes within the suborder Ceratioidei. Males are one-third the size of females or smaller and sometimes are permanently attached (parasitic) to them. Eggs of most lophiiforms are spawned in gelatinous "veils" which may be up to 1.5 m wide and 12 m long (Pietsch 1984). Several species have eggs attached to the adult (Pietsch and Grobecker 1987). Larvae are pelagic and many have large heads and an envelope of highly inflated skin. Neither eggs nor larvae have been collected in the study area.

Families in study area: **Ceratiidae**
**Oneirodidae**

The suborder Ceratioidei is represented within the study area by members of the families Oneirodidae and Ceratiidae. Ceratioids differ from other members of the Lophiiformes in being meso- and bathypelagic, lacking pelvic fins (except larval Caulophrynidae), and in having extreme sexual dimorphism.

## Oneirodidae

Found worldwide, oneirodids (dreamers) are represented by five species within three genera (*Oneirodes*, *Chaenophryne*, and *Bertella*) in the Northeast Pacific. Reproduction is accomplished by facultative or non-parasitic attachment of the male onto the body of the female (Pietsch 1976). Eggs and larvae are pelagic. Eggs are probably released in gelatinous veils which might break up in plankton nets. Eggs are presumably small, generally 0.5-0.8 mm, and hatching occurs between 2.5 and 3.5 mm SL (Bertelsen 1984). Larvae have a transparent envelope of gelatin, under colorless skin, which may serve as an aid to flotation (Idyll 1964, Pietsch 1984).

According to Bertelsen (1984), larval characters for oneirodids include the following:

- Presence in larval males of a rudiment of illical bone
- Moderately elongate body shape (body depth up to 80-90% in most ceratioids but less pronounced in oneirodids)
- Larvae surrounded by inflated transparent skin (similar to other ceratioids)
- Head length usually about 45% SL
- Pigment: Ceratioids possess four main pigment areas (peritoneal, dorsal, caudal, and opercular). In oneirodids, the opercular pigment is dense and occurs in different patterns

At metamorphosis (usually between 8 and 10 mm SL), larvae descend into deeper waters.

## Ceratiidae

Recently, two ceratiids (seadevils) have been identified from the Bering Sea, *Ceratias holboelli* and *Ceratias* sp. (Pietsch 1986). Larval ceratiids are distinguished from other ceratioid families in having the following combination of characters (Pietsch 1986):

- Body "hump-backed," mouth subvertical
- Female with caruncles on dorsal surface of trunk
- 4-5 dorsal fin rays, 4 anal fin rays
- Pectoral fins not reaching beyond dorsal and anal fins
- Pelvic fins absent

**Table 27**
**Meristic characters of Ceratioidei.**

| Taxon | Distribution | Vertebrae: Precaudal (Total) | Vertebrae: Caudal | Fins: Dorsal | Fins: Anal | Fins: Pectoral | Branchiostegals |
|---|---|---|---|---|---|---|---|
| **Ceratiidae** | | | | | | | |
| *Ceratias holboelli* | Bering Sea | | | 4-5 | 4 | | |
| *Ceratias* sp. | Bering Sea | | | 4-5 | 4 | | |
| **Oneirodidae** | | | | | | | |
| *Bertella idiomorpha* | SSC - Gulf of Alaska | 5 | 15 | 5-6 | 4-5 | 17-21 | 6 |
| *Chaenophryne longiceps* | SSC - Oregon | (21) | | 6-7 | 5-6 | 17-22 | 6 |
| *Chaenophryne melanorhabdus* | SSC - Brit. Col. | 9 | 10 | 6-8 | 5-6 | 16-17 | 6 |
| *Oneirodes bulbosus* | Oregon - Bering Sea | 4 | 16 | 6-7 | 4 | 15-18 | 6 |
| *Oneirodes thompsoni* | N. Calif. - Bering Sea | 4 | 16 | 5-6 | 4 | 14-17 | 6 |

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 21-21-21 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Absent | |
| **Dorsal fin** | R: 6-7-7 | |
| **Pectoral fin** | R: 17-19-22 | |
| **Anal fin** | R: 5-5-6 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Oregon, 42-46°N |
| **Ecology** | Mesopelagic, 200-1000 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: Males attach to body of female[a] |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE[b]

**Preanal length**
**Length at flexion**
**Length at transformation**
**Sequence of fin development**
**Pigment**

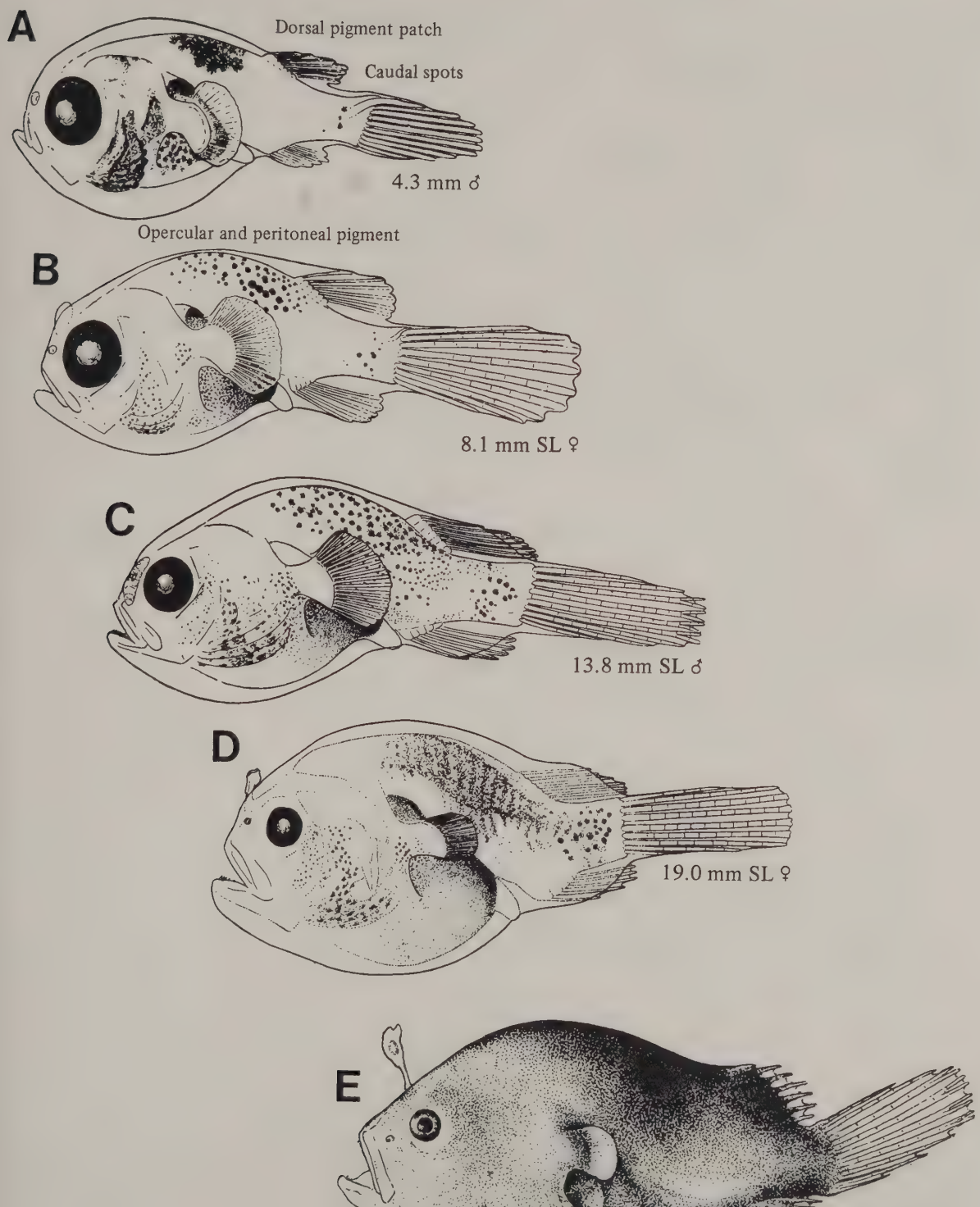
- Pigment appears in all four pigment areas
  - —Peritoneal
  - —Anterior body, begins as a small dorsal patch
  - —Opercular
  - —Caudal, initially a few spots

**Diagnostic characters**

- Generally more lightly pigmented than *Oneirodes* spp.

[a] Pietsch 1976
[b] Because of the possibility of involvement of other species in the description, and geographic variation, specimens in our area could differ.

Ref: Bertelsen 1984.




Figures A–E, Bertelsen 1951 (North Atlantic specimens).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 20-20-20 |
| | Precaudal: 4-4-4 |
| | Caudal: 16-16-16 |
| **Branchiostegal rays** | 6-6-6 |
| **Caudal fin** | |
| **Pelvic fin** | Absent |
| **Dorsal fin** | R: 6-X-7 |
| **Pectoral fin** | R: 15-16-18 |
| **Anal fin** | R: 4-4-4 |
| **Gill rakers** | U: X-X-X L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Oregon, 42-46°N, to Bering Sea, 54-66°N |
| **Ecology** | Mesopelagic, 200-1000 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: Males attach to body of female[a] |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE[b]

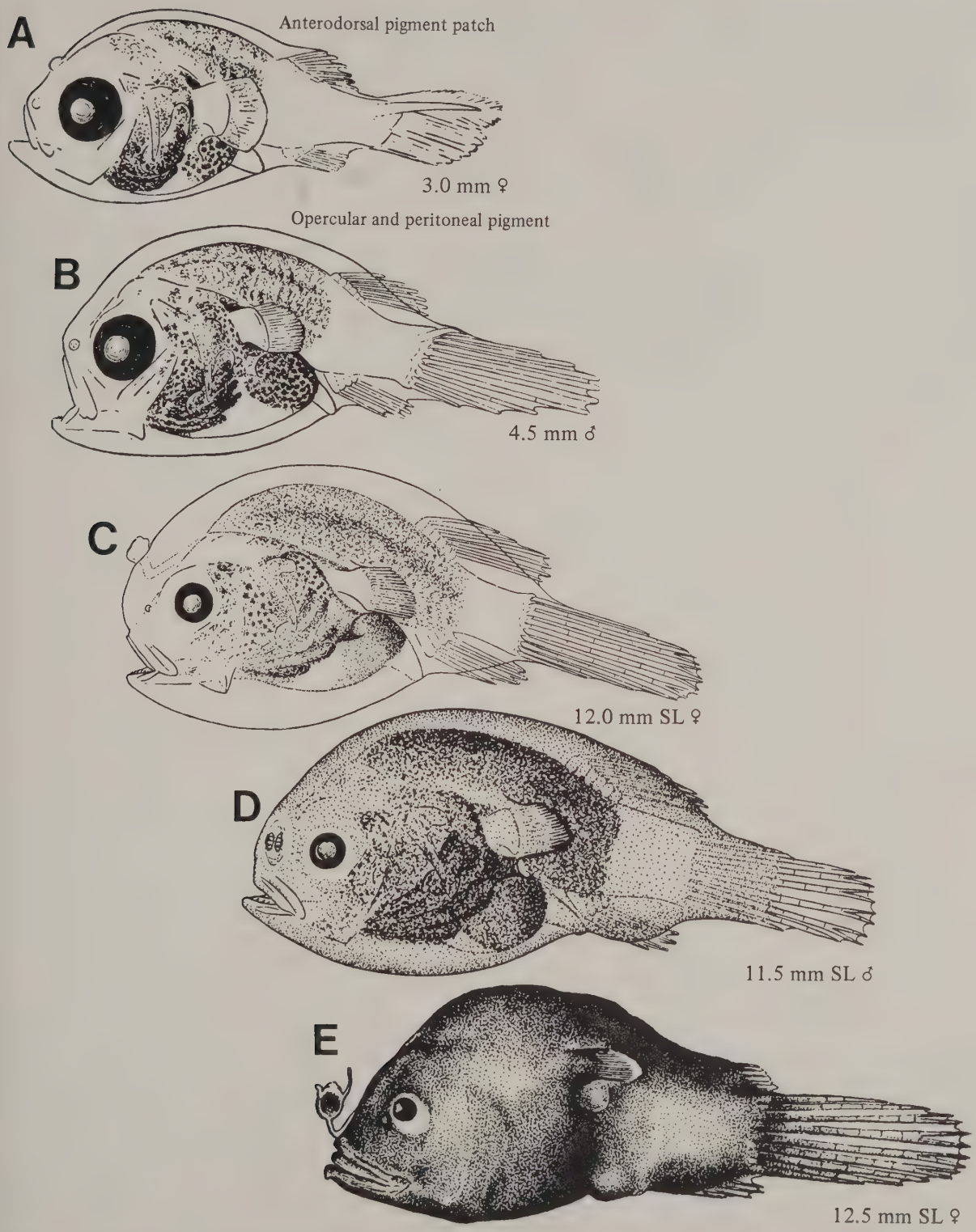
**Preanal length**
**Length at flexion**
**Length at transformation**
**Sequence of fin development**
**Pigment** - Species group

- Pigment in three out of the four main pigment areas
  —Peritoneal
  —Anterior body
  —Opercular
- Caudal pigment is light and appears late in development

**Diagnostic characters**

[a] Pietsch 1976
[b] Figures of *Oneirodes eschrichti* group (Bertelsen 1951) are presented for comparison only. Because of the possibility of involvement of other species in the description, and geographic variation, specimens of *Oneirodes* in our area could differ.

Ref: Bertelsen 1984.




Figures A–E, Bertelsen 1951 (North Atlantic specimens from the *O. eschrichti* group).

## Gobiesociformes

The gobiesociforms (clingfishes) are mostly small, inshore bottom-dwelling species occurring in tropical and temperate seas. Noted primarily for having the pelvic fins modified into a sucking disc, the order has 2 families, 36 genera, and 114 species (J. Nelson 1984). All but one genus and four species are members of Gobiesocidae. Eggs are demersal, attached to substrate or kelp, ovate to ellipsoidal, and 0.7-1.9 mm. Oil globules (1-100) coalesce to one during development (Allen 1984). Larvae are well developed at hatching and may have a fully formed pelvic disc at this time (Marliave 1975a). Most are heavily pigmented and have long guts (50-70% SL) (Allen 1984).

Family in study area: **Gobiesocidae**

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 32-33-34<br>Precaudal: 12-14-14<br>Caudal: 19-19-20 |
| **Branchiostegal rays** | 6-6-6 |
| **Caudal fin** | Total rays = 11-13 |
| **Pelvic fin** | Disc<br>S: 1-1-1 R: 4-4-4 |
| **Dorsal fin** | R: 13-16-16 |
| **Pectoral fin** | R: 21-22-23 |
| **Anal fin** | R: 13-14-15 |
| **Gill rakers** | U: X-X-X L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to SE Alaska, 55-59°N |
| **Ecology** | Intertidal, nearshore, 0-8 m |
| **ELH pattern** | Oviparous; demersal, attached, guarded eggs; pelagic larvae |
| **Spawning** | Season: Winter-spring (British Columbia)[a]<br>Area: Demersal, on underside of rocks, usually intertidal[a]<br>Mode: Polygamous males guard eggs (laid in monolayer)[a]<br>Migration: |
| **Fecundity** | Range/function: 194-382 per female[b] |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.68-1.92 mm (1.78) |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | Bilobed in embryo and yolksac larva |
| **Envelope** | |
| **Hatch size** | 5.7 mm SL, yolksac present until 6.2 mm SL |
| **Incubation time/temp.** | 30 d/9-11°C |
| **Pigment** | |

**Diagnostic characters**

- Adhesive, hemispherical, flat at point of attachment

### LARVAE

| | |
|---|---|
| **Head length** | 21-35% SL; gut length (preanal minus head length) 25% SL |
| **Length at flexion** | 7 mm SL |
| **Length at transformation** | 10-13 mm SL |
| **Sequence of fin development** | Pectoral fin buds form at 7.0 mm SL; pelvic disc is formed by 7.3 mm SL and fully functioning by 9.1 mm SL |

**Pigment**

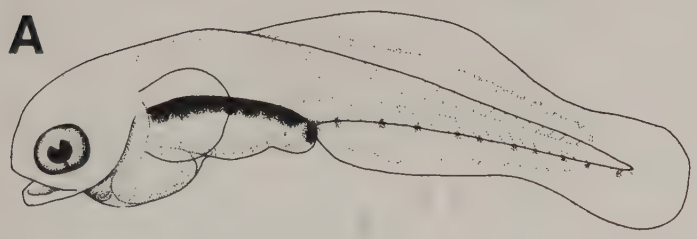
- Dorsally on gut
- With development, on snout and dorsal region of head

**Diagnostic characters**

- Large melanophores on dorsal surface of gut, lack of pigment on lateral surface
- Forms pelvic disc
- Number of myomeres (32-34)

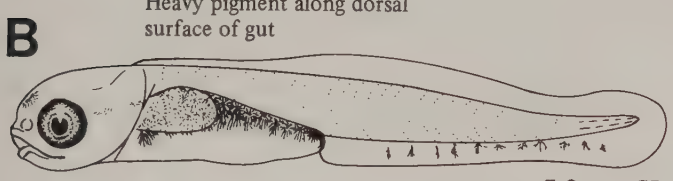
[a] Marliave 1975a
[b] Johnson 1970

Ref: Allen 1984, Allen and Ilg 1983.



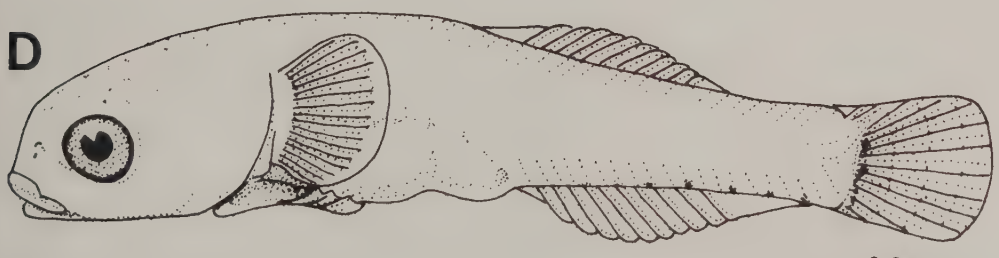

5.8 mm SL

Heavy pigment along dorsal surface of gut

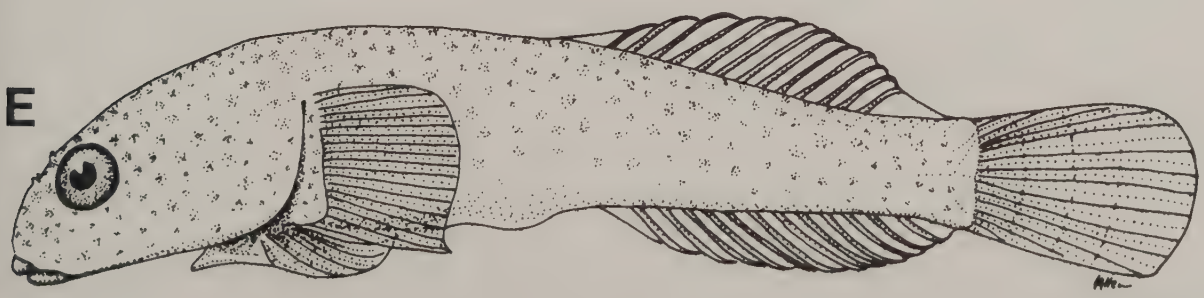



7.0 mm SL

7.3 mm SL




9.8 mm SL




13.0 mm SL

Figures A, C–E, Allen and Ilg 1983; B, NWAFC original (B. Vinter).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 35-X-36 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 5-X-7 |
| **Caudal fin** | Total rays=8 |
| **Pelvic fin** | Disc |
| | S: 1-1-1 R: 4-4-4 |
| **Dorsal fin** | R: 6-7-8 |
| **Pectoral fin** | R: 14-15-17 |
| **Anal fin** | R: 6-7-8 |
| **Gill rakers** | U: X-X-X L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Brit. Col., 48°30′-55°N |
| **Ecology** | Intertidal, nearshore |
| **ELH pattern** | Oviparous; demersal, attached eggs; pelagic larvae |
| **Spawning** | Season: |
| | Area: Kelp beds, on blades[a] |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.3 mm |
| **No. of oil globules** | One |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | <4 mm SL; yolksac present at 4 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | ~50% SL |
| **Length at flexion** | |
| **Length at transformation** | |
| **Sequence of fin development** | |

**Pigment** (based on figure only)

- Lateral melanophores (40-50)
- No postanal ventral melanophores
- No hypural pigment

**Diagnostic characters**

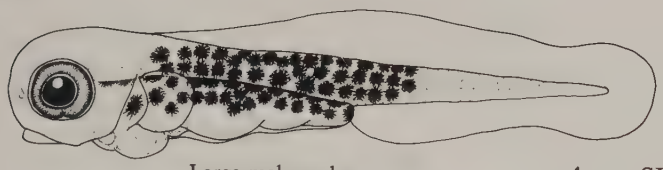
- Pelvic disc at hatching
- Number of myomeres (35-36)

Note: Marliave (1975a) reared *Rimicola muscarum* in the laboratory. Eggs (1.3 mm in diameter) had a single oil globule, and late-stage embryos developed a pelvic disc. Hatching occurred when embryos reached 4.0 mm SL. He described them as identical to *Gobiesox maeandricus* larvae except that they were markedly smaller, without nasal pigment, and with the pelvic disc at hatching. According to Marliave (Vancouver Public Aquarium, P.O. Box 3232, Vancouver, B.C., Canada V6B 3X8, pers. commun., 16 Oct. 1986), *R. muscarum* probably lacks a pelagic stage and the specimen illustrated here from Allen (1979) is misidentified.

[a] Allen 1984

Ref: Allen 1979, Marliave 1975a.

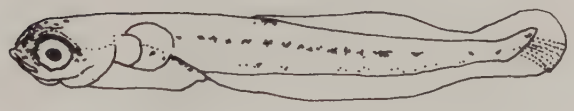
A



Large melanophores
on anterior body

4 mm SL

Figure A, Allen 1979.



## Atherinomorpha: Beloniformes
## Atheriniformes

The Beloniformes and Atheriniformes together comprise a group of fishes found in freshwater and marine habitats within tropical and temperate areas. The Beloniformes (not always accorded ordinal status [J. Nelson 1984]), consists of 5 families, 37 genera, and 180 species (Collette et al. 1984a). Marine forms of this order are mostly epipelagic, the best known being exocoetids, or flying fish. There are 6 families (White et al. 1984), 49 genera, and 235 species of atheriniforms (J. Nelson 1984). The two orders belong to the superorder Atherinomorpha and share the development of large demersal eggs with filaments and oil globules that coalesce at the vegetal pole (Collette 1984). Filaments may be short or long, grouped or evenly scattered, and adhesive or non-adhesive. Beloniform larvae are well formed at hatching and many have a preanal finfold and beak-like jaws (Collette et al. 1984a). Atheriniform larvae have direct development (i.e., no specialized larval or juvenile stages), a preanal finfold, and a single row of melanophores on the dorsal midline (White et al. 1984).

Families in study area: **Scomberesocidae**
**Atherinidae**

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 62-65-69 |
| | Precaudal: 37-38-40 |
| | Caudal: 24-27-29[a] |
| **Branchiostegal rays** | 14-X-15 |
| **Caudal fin** | X, 7+8, X |
| **Pelvic fin** | Abdominal |
| | R: 6-6-6 |
| **Dorsal fin** | R: 14-X-18[a] |
| **Pectoral fin** | R: 12-13-15 |
| **Anal fin** | R: 18-X-21[a] |
| **Gill rakers** | U: X-X-X L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Bering Sea, 54-66°N |
| **Ecology** | Epipelagic, 0-200 m |
| **ELH pattern** | Oviparous, eggs attach to flotsam (kelp) with adhesive filaments, pelagic larvae |
| **Spawning** | Season: Winter-fall;[b] peaks Feb-July[c] |
| | Area: |
| | Mode: Schools[b] |
| | Migration: |
| **Fecundity** | Range/function: ~1800 during each of 6-7 spawnings[b] |
| **Age at first maturity** | 2 yr[b] |
| **Longevity** | 5 yr[b] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.58 (1.68 mm)×2.13 mm |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous |
| **Envelope** | Adhesive filaments, 12-15 in polar cluster and 1 lateral |
| **Hatch size** | 6.0-8.5 mm SL (family) |
| **Incubation time/temp** | |
| **Pigment** | |

**Diagnostic characters**

- Adhesive filaments in polar cluster
- Single lateral filament
- Slightly ovoid

### LARVAE

| | |
|---|---|
| **Preanal length** | 65% SL |
| **Length at flexion** | |
| **Length at transformation** | |
| **Sequence of fin development** | Caudal, dorsal and anal, pectorals, pelvics (caudal forms at hatching) |

**Pigment**

- Dense body pigment

**Diagnostic characters** (see Table 3)

- Persistent preanal finfold
- Unpigmented area on ventrolateral region of caudal peduncle
- At 20-40 mm SL, upper and lower jaw are slightly elongate but do not form prominent beak; with growth a slight beak develops

[a] Collette et al. 1984a
[b] Fitch and Lavenberg 1971
[c] Wang 1981

Ref: Collette et al. 1984a, Fitch and Lavenberg 1971, Uchida et al. 1958.

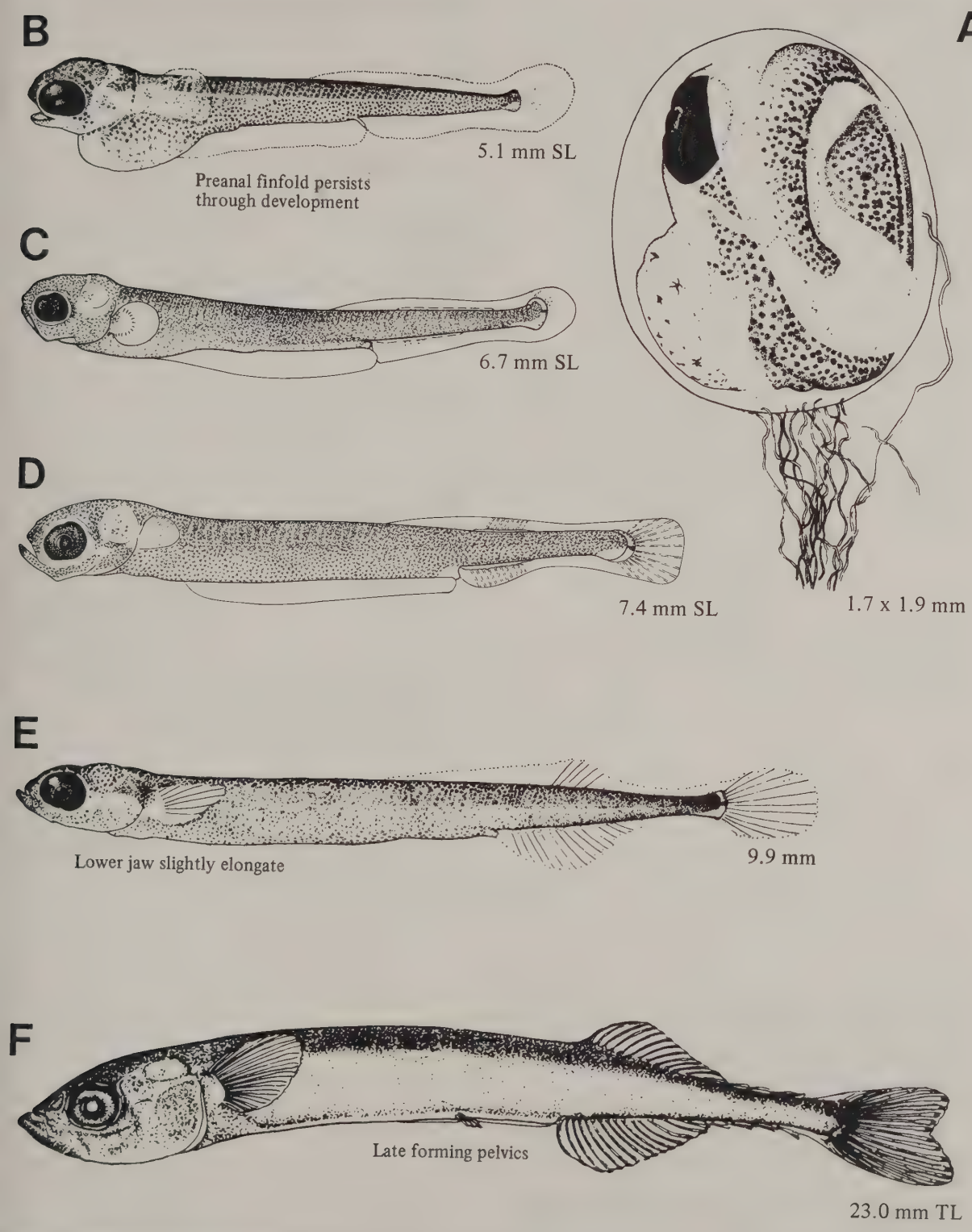



Figure A, Matarese and Sandknop 1984; B, Collette et al. 1984a; C–D, NWAFC originals (B. Vinter); E, Moser 1981; F, Uchida et al. 1958.

## MERISTICS[a]

| | | |
|---|---|---|
| **Vertebrae** | Total: 44-48-52 | |
| | Precaudal: 32-34-37 | |
| | Caudal: 11-13-15 | |
| **Branchiostegal rays** | 5-X-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Abdominal | |
| | S: 1-1-1 | R: 5-5-5 |
| **Dorsal fin** | S: 6-X-10 | R: 8-X-14 |
| **Pectoral fin** | R: 13-13-13 | |
| **Anal fin** | S: 1-1-1 | R: 19-X-25 |
| **Gill rakers** | U: 4-X-8 | L: 21-X-34 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Brit. Col., 48°30′-55°N |
| **Ecology** | Nearshore shelf pelagic |
| **ELH pattern** | Oviparous, eggs with adhesive filaments, pelagic larvae |
| **Spawning** | Season: May-July[b]<br>Area: Mudflats, eelgrass[b]<br>Mode: Schools[b]<br>Migration: To mudflats in sloughs[a] |
| **Fecundity** | Range/function: |
| **Age at first maturity** | 2-3 yr[c] |
| **Longevity** | 6-7 yr[b] |

## EARLY LIFE HISTORY DESCRIPTION[d]

### EGGS

| | |
|---|---|
| **Diameter** | 1.5-1.7 mm[e] |
| **No. of oil globules** | Initially may have one to many, but they usually coalesce to one |
| **Oil globule diameter** | |
| **Yolk** | Amber, granular |
| **Envelope** | 6-7 filaments[f] |
| **Hatch size** | 4.3-4.9 mm SL; yolk absorbed by 7 mm SL |
| **Incubation time/temp.** | 9 d/15-18°C |

**Pigment**

- Dorsal and lateral spots on head, few anterior spots on yolksac

**Diagnostic characters**

- Narrow perivitelline space

### LARVAE

| | |
|---|---|
| **Preanal length** | 30-40% SL |
| **Length at flexion** | 7.7-10.5 mm SL |
| **Length at transformation** | 15 mm SL |
| **Sequence of fin development** | Caudal, pectorals, anal rays and 2nd dorsal, pelvics, 1st dorsal and anal spines |

**Pigment**

- Dorsal midline from snout to caudal peduncle
- Mediolateral beginning above gut
- Dorsal and ventral surface of gut
- Ventrally on tail

**Diagnostic characters**

Distinguished from *Atherinopsis californiensis* by

- Presence of melanophores along ventral body midline and ventral gut

---

[a] Meristic information from White et al. (1984) is very different from the information in our database. Due to confusion in the literature over the definition of spines and rays, only total elements are reported by White et al. (1984) and they are as follows:

| | | | |
|---|---|---|---|
| Vertebrae | 43-49 | Pectoral fin | 12-15 |
| First dorsal fin | 3-7 | Anal fin | 9-14 |
| Second dorsal fin | 10-14 | Gill rakers | 14-27 |

[b] Hart 1973

[c] Fitch and Lavenberg 1975

[d] Additional unpubl. data provided by W. Watson, H.J. Walker, and R. Davis (W. Watson, Marine Ecological Consultants, 531 Encinitas Blvd., Suite 110, Encinitas, CA 92024, pers. commun., 3 Nov. 1986).

[e] Wang 1981

[f] According to White et al. (1984), two egg types are reported for the species, one with 40-78 filaments attached at both ends and the other with about 6 filaments attached only at one end.

Ref: Wang 1981, White et al. 1984.

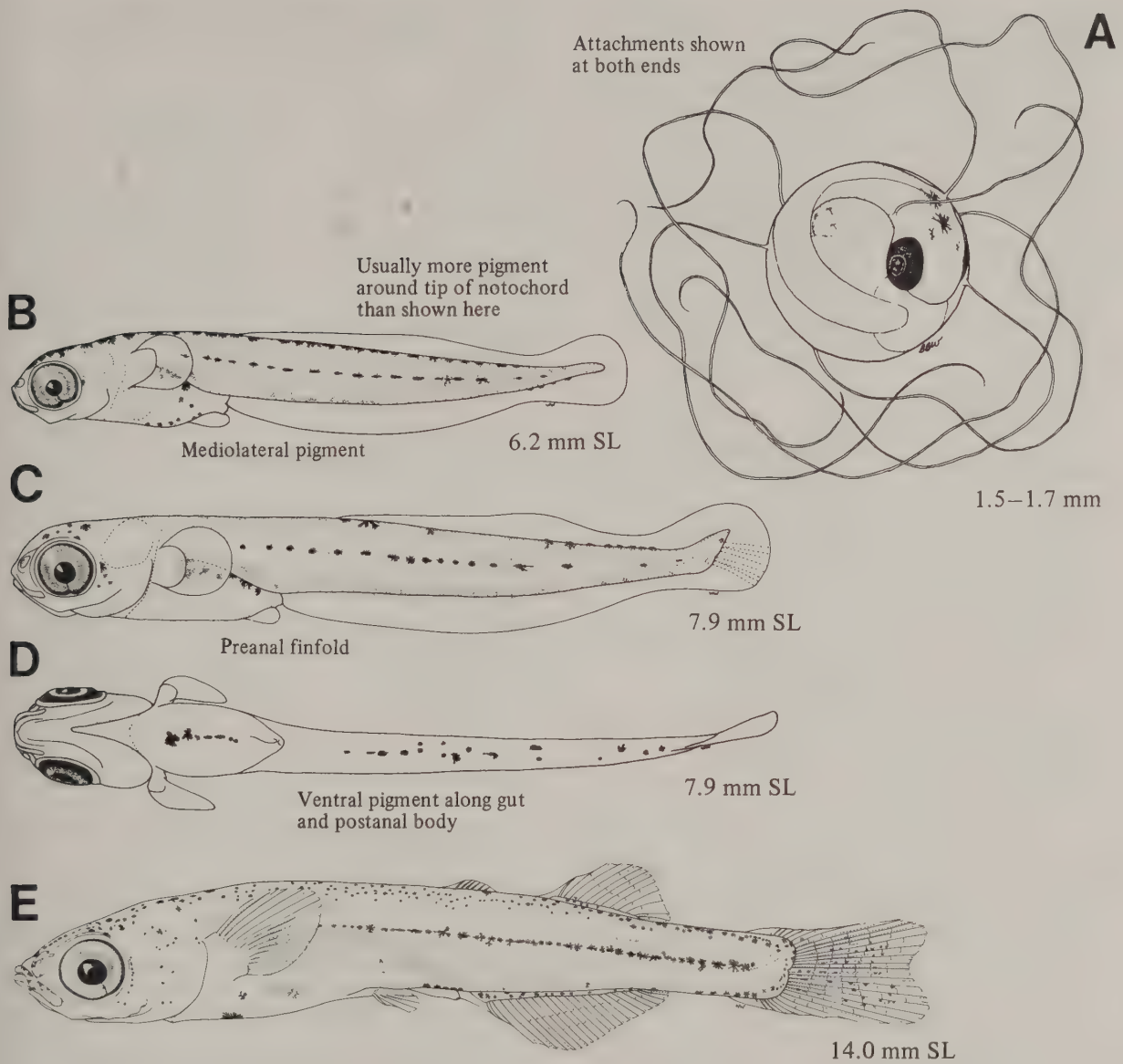



Figure A, White et al. 1984; B–E (D, ventral view), Watson and McGowen, unpubl.

## MERISTICS[a]

| | | |
|---|---|---|
| **Vertebrae** | Total: 50-51-52 | |
| | Precaudal: 9-12-14 | |
| | Caudal: 37-39-41 | |
| **Branchiostegal rays** | 5-X-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Abdominal | |
| | S: 1-1-1 | R: 6-6-6 |
| **Dorsal fin** | S: 6-X-10 | R: 11-X-14 |
| **Pectoral fin** | R: 15-15-15 | |
| **Anal fin** | S: 1-1-1 | R: 21-X-26 |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Oregon, 42-46°N |
| **Ecology** | Nearshore shelf pelagic |
| **ELH pattern** | Oviparous, eggs with filaments in a mass or attached to substrate, pelagic larvae |
| **Spawning** | Season: Fall-spring[b] |
| | Area: On algae, eelgrass[b] |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION[c]

### EGGS

| | |
|---|---|
| **Diameter** | 1.9-2.5 mm[b] |
| **No. of oil globules** | Many (23-44) which coalesce to one or few |
| **Oil globule diameter** | 0.4-0.6 mm (consolidated) |
| **Yolk** | Yellow-orange, granular |
| **Envelope** | 13-19 filaments scattered on surface |
| **Hatch size** | 7.5-8.6 mm SL; yolk absorbed by 10 mm SL |
| **Incubation time/temp.** | 17-19 d/12-16°C |

**Pigment**

- Dorsal spots along nape

**Diagnostic characters**

- Narrow perivitelline space
- 1-2 cm filaments

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | 8.8 to ⩽11.5 mm SL |
| **Length at transformation** | 18.1-19.5 mm SL |
| **Sequence of fin development** | Caudal, pectorals, anal rays and 2nd dorsal, pelvics, 1st dorsal and anal spines |

**Pigment**

- Dorsal midline from snout to caudal peduncle, sometimes with a break in nape area
- Mediolateral usually begins posterior to gut during preflexion stage

**Diagnostic characters**

Distinguished from *Atherinops affinis* by

- First 5-6 postanal myomeres always lack ventral pigment through the larval and early juvenile stages
- Lack of ventral midline melanophores until midflexion
- Mediolateral pigment originates further posterior

[a] Meristics from White et al. (1984) are as follows:

| | |
|---|---|
| Vertebrae | 46-53 |
| First dorsal fin | 4-9 |
| Second dorsal fin | 10-15 |
| Pectoral fin | 14-17 |
| Anal fin | 20-29 |
| Gill rakers | 18-44 |

[b] Wang 1981

[c] Additional unpubl. data provided by W. Watson, H.J. Walker, and R. Davis (W. Watson, Marine Ecological Consultants, 531 Encinitas Blvd., Suite 110, Encinitas, CA 92024, pers. commun., 3 Nov. 1986).

Ref: Wang 1981, White et al. 1984.

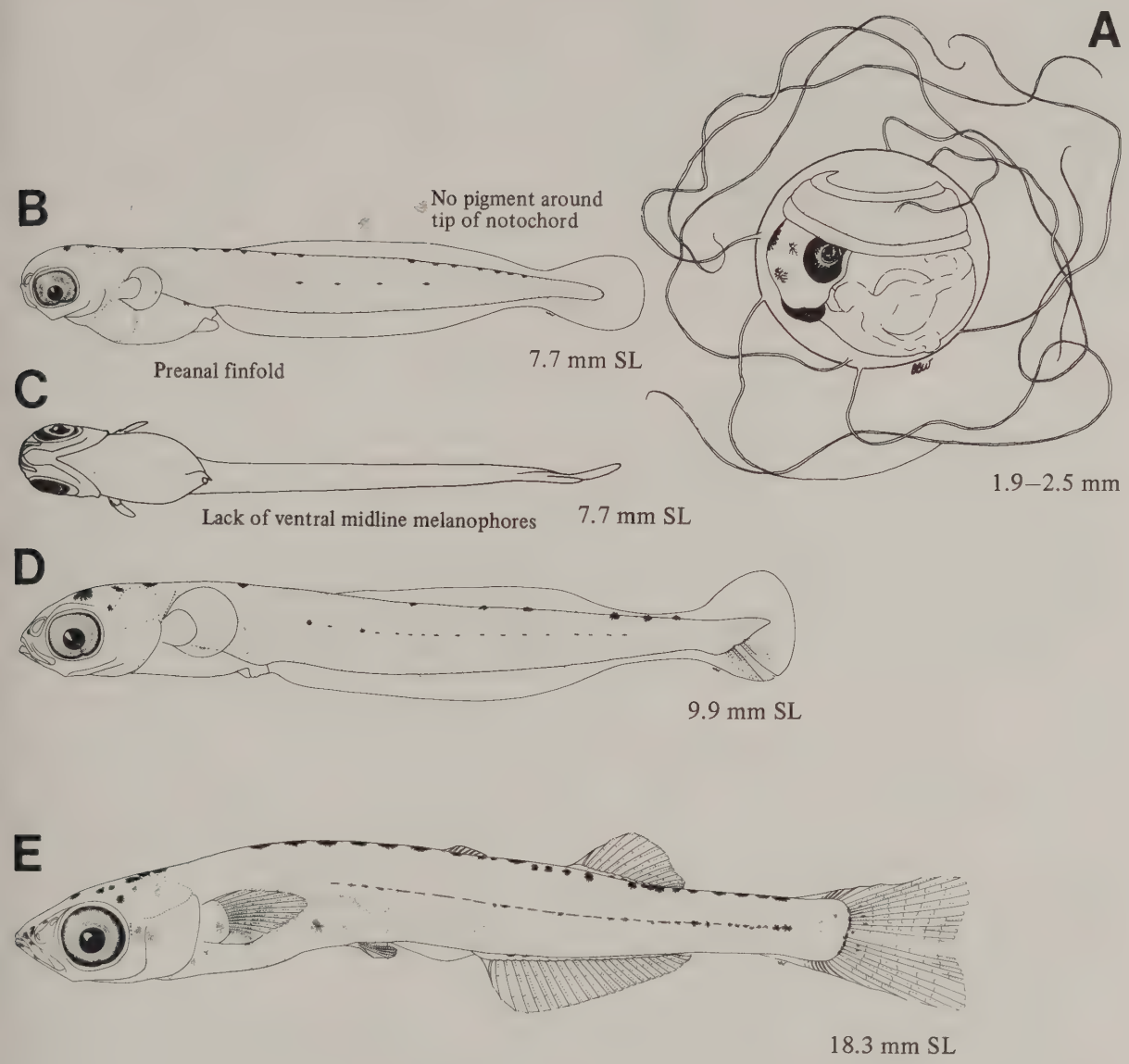
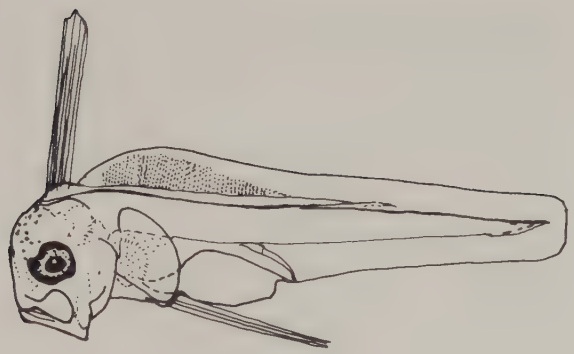



Figure A, White et al. 1984; B–E (C, ventral view), Watson and McGowen, unpubl.



## Lampriformes

Fishes of the order Lampriformes are extremely diverse. Occupying meso- and epipelagic habitats, some are deep-bodied while others are long and ribbon-like. Extreme specialization and unique body shapes have caused conflicting proposals for evolutionary relationships within the order (Olney 1984). According to Olney (1984), there are 7 families, 12 genera, and 21 families worldwide (not found in polar seas). Lampriforms share the unique arrangement of protrusible premaxilla and maxilla, or specializations thereof. Early-life-history information is available for only four genera. Eggs are large (1.7-4.0 mm) with thick resilient chorions, pelagic, and may be shaded with amber, pink, or red hues. Advanced stages of eggs of some forms are easily recognized due to precocious development of anterior dorsal and pelvic rays and distinctive pigment patterns. Newly hatched lampriforms are identified by their well-developed protrusible jaws and elongate anterior dorsal and pelvic fin elements which are often ornamented with highly pigmented serial or terminal swellings (Olney 1984).

Families in study area: **Lampridae**
**Trachipteridae**

## MERISTICS[a]

| | |
|---|---|
| **Vertebrae** | Total: 43-X-46 |
| | Precaudal: 19-X-21 |
| | Caudal: 23-24-25 |
| **Branchiostegal rays** | 6-X-7 |
| **Caudal fin** | Total rays=30-32 |
| **Pelvic fin** | Abdominal |
| | R: 13-X-17 |
| **Dorsal fin** | R: 48-X-52 |
| **Pectoral fin** | R: 21-X-24 |
| **Anal fin** | R: 33-X-42 |
| **Gill rakers** | U: 2-X-3 L: 13-X-14 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Gulf of Alaska, 54-60°N |
| **Ecology** | Epi- and mesopelagic |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Spring[b] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS - Family

| | |
|---|---|
| **Diameter** | Large, 1.7-4.0 mm |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous in known forms |
| **Envelope** | Thick, resilient |
| **Hatch size** | |
| **Incubation time/temp.** | ~3 weeks |
| **Pigment** | |

**Diagnostic characters**

- Precocious development of fins
- Ovarian eggs have thick chorion with amber tint

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL, increasing with development to ⩾50% SL |
| **Length at flexion** | |
| **Length at transformation** | |
| **Sequence of fin development** | Anterior dorsal and pelvics precocious; dorsal, anal, and caudal; pectorals |

**Pigment**

- Initially on crown and dorsal surface of gut; with development, increases along entire body except for tail region and above anal fin

**Diagnostic characters**

Distinguished from *Trachipterus altivelis* (p. 246) by

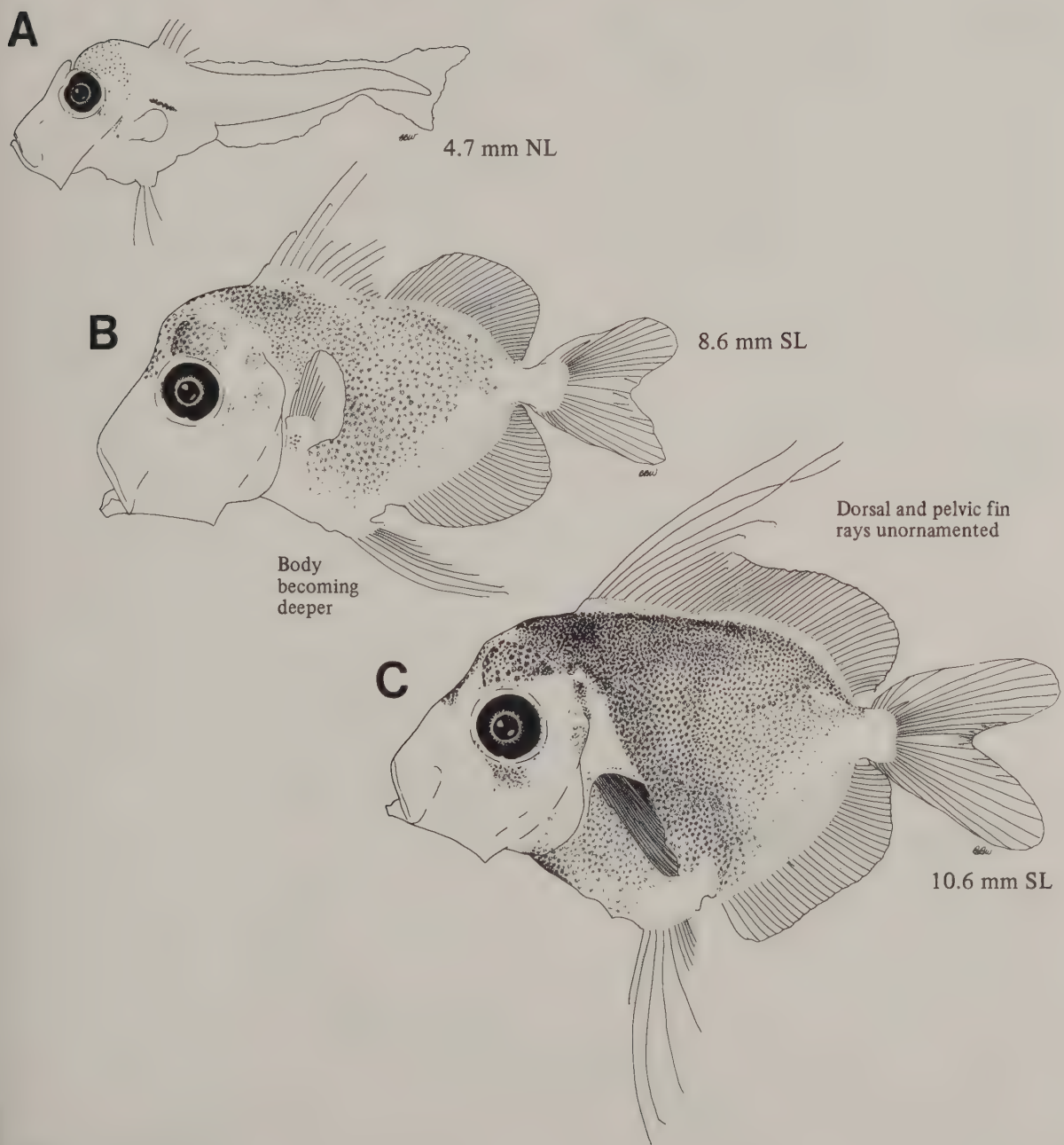
- Lack of ornamentation on dorsal and pelvic fins (when fins are intact)
- Rapid change in body form from slender at hatching to deep-bodied by 10.6 mm SL

Lampriform characters

- Well-developed protrusible jaws
- Differentiated guts with open lumen and little yolk
- Elongate anterior dorsal elements (may be ornamented) and well-developed pelvic elements (may be ornamented with lengths to 40-60% NL)

[a] Data from Olney (1984) in part, only total elements reported.
[b] Fitch and Lavenberg 1971

Ref: Olney 1984.




Figures A–C, Olney 1984.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 90-92-94 |
| | Precaudal: 35-35-39 |
| | Caudal: 53-59-59 |
| **Branchiostegal rays** | 6-X-7 |
| **Caudal fin** | |
| **Pelvic fin** | Thoracic |
| | R: 6-X-7 |
| **Dorsal fin** | R: 160-X-191 |
| **Pectoral fin** | R: 10-X-11 |
| **Anal fin** | Absent |
| **Gill rakers** | U: 3-X-5 L: 9-X-11 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Gulf of Alaska, 54-60°N |
| **Ecology** | Epi- and mesopelagic, 0-900 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 2.6-3.7 mm |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous |
| **Envelope** | Clear, smooth, thick |
| **Hatch size** | |
| **Incubation time/temp.** | |

**Pigment**

- Head and gut
- Finfold
- Ornamentation on elongate rays

**Diagnostic characters**

- Precocious development of elongate rays in anterior dorsal fin and pelvic fins

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL, with development increasing to >50% SL |
| **Length at flexion** | |
| **Length at transformation** | |
| **Sequence of fin development** | Anterior dorsal and pelvics precocious, posterior dorsal, caudal, pectorals |

**Pigment**

- Initially only on head and anterior/dorsal gut; with development pigment appears on lateral surface of gut, along body over gut, and in a series above notochord along 3/4 BL
- Several spots develop above and below notochord in caudal region

**Diagnostic characters**

- See *Lampris guttatus* (p. 244)

Ref: NWAFC, unpubl.

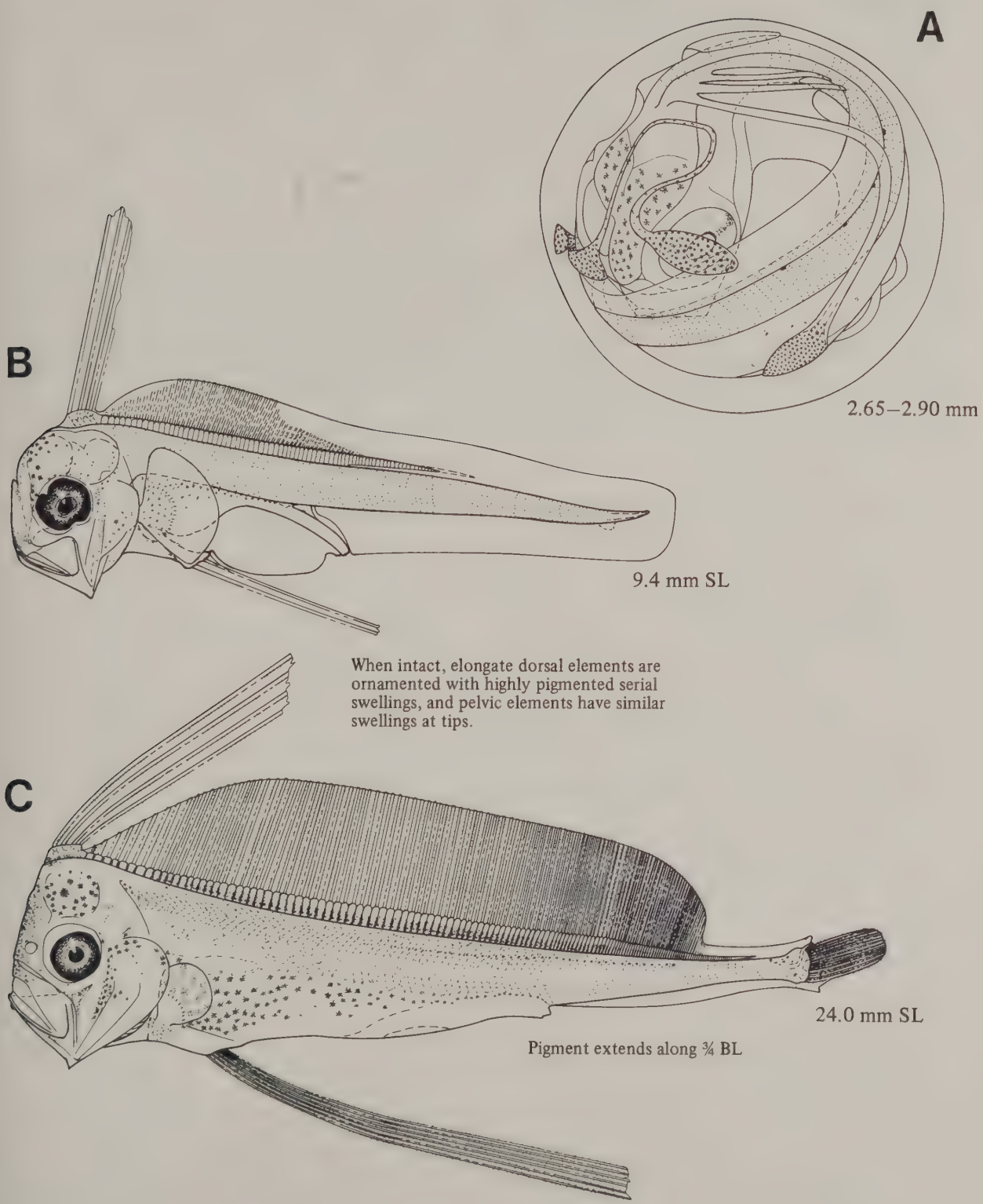

A
2.65–2.90 mm
B
9.4 mm SL
When intact, elongate dorsal elements are ornamented with highly pigmented serial swellings, and pelvic elements have similar swellings at tips.
C
24.0 mm SL
Pigment extends along ¾ BL

Figure A, Matarese and Sandknop 1984; B–C, NWAFC originals (B. Vinter).

## Beryciformes

Fishes of the order Beryciformes are cosmopolitan in distribution. The composition of the order is subject to much variation, but according to Keene and Tighe (1984), it consists of 16 families, 42 genera, and 155 species. Although several characters define the beryciforms (e.g., a high number of pelvic and caudal fin rays and the presence of dorsal, anal, and pelvic fin spines), none are unique to the order. No information is available on eggs, and other early-life-history stages are known for only six families. In the Northeast Pacific, larvae are known for only two families, Anoplogastridae and Melamphaidae. Anoplogastrids have large heads with short deep bodies, and well-developed preopercular, rostral, and cranial spines. Larvae of the best known family, Melamphaidae, are longer-bodied and more slender with spination generally restricted to the preopercle.

A summary of meristic characters is provided for members of the suborder Cetomimoidei (Barbourisiidae, Cetomimidae, Rondeletiidae), as larvae are unknown.

Families in study area: **Anoplogastridae**
**Melamphaidae**
**Barbourisiidae**
**Cetomimidae**
**Rondeletiidae**

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 25-X-28 |
| | Precaudal: 12-12-12 |
| | Caudal: 16-16-16 |
| **Branchiostegal rays** | 8-X-9 |
| **Caudal fin** | X, 17, X |
| **Pelvic fin** | Thoracic |
| | S: 1-1-1 R: 6-6-6 |
| **Dorsal fin** | R: 17-18-19 |
| **Pectoral fin** | R: 14-15-16 |
| **Anal fin** | R: 8-X-9 |
| **Gill rakers** | U: 7-X-11 L: 7-X-11 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Oregon, 42-46°N |
| **Ecology** | Epi- and mesopelagic, below 610 m |
| **ELH pattern** | Parity and eggs unknown, pelagic larvae |
| **Spawning** | Season: Summer (California)[a] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

**Preanal length**
**Length at flexion** 4.5-6.0 mm SL
**Length at transformation**
**Sequence of fin development** Pelvic fins last to develop
**Pigment**

- At 6 mm SL, lateral surface of body to caudal peduncle, gut, and pectoral fin base pigmented
- Pigment increases with development

**Diagnostic characters**

- Spination
  - —Serrate frontal ridge terminates in a short stout supraocular spine
  - —Long serrate parietal spine
  - —Long serrate preopercular spine directed posteroventrad

Juveniles

- Increase in dark pigment
- Reduction of spines

[a] Fitch and Lavenberg 1968

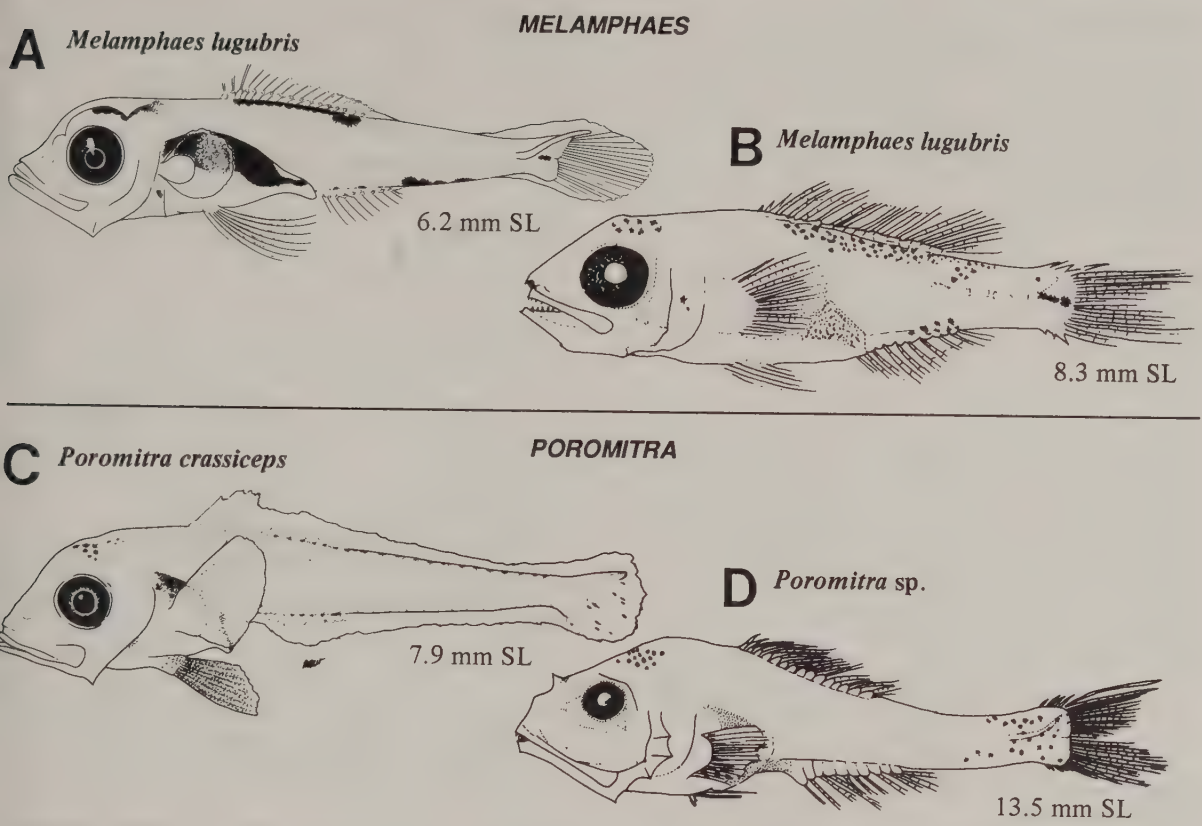
Ref: Keene and Tighe 1984.

Figure A, Keene and Tighe 1984.

# MELAMPHAIDAE

Melamphaids, or bigscales, are small (15 cm), darkly colored, bathypelagic fish found in most oceans. They are distinguished by exceptionally thin skull bones, sometimes with ridges or crests. They are represented in the study area by five species within four genera: *Melamphaes*, *Poromitra*, *Scopeloberyx*, and *Scopelogadus*. A complete descriptive series is known only for *Melamphaes lugubris*. Generally, small melamphaid larvae (2-10 mm) are relatively elongate and slender as compared with later stages, and possess early and rapidly developing pelvic fins which are long and darkly pigmented. *Melamphaes*, *Scopeloberyx*, and *Scopelogadus* larvae usually have two spots near the posterior end of the dorsal and anal fin margin; with development these spots spread both anteriorly and posteriorly along the dorsal and ventral midlines (Keene and Tighe 1984). Other pigment occurs on the cranium, peritoneum, and along the caudal peduncle. Although usually damaged, the second or third dorsal fin ray is elongate in larvae of these three genera. Larger larvae (5-10 to 20 mm) can generally be distinguished by body shape, presence of preopercular spines (e.g., *Poromitra*), and meristic characters. The following generic meristic characters are based on Ebeling (1962) and E.H. Ahlstrom notes, in part.

| | | Fins | | | |
|---|---|---|---|---|---|
| Genus | Vertebrae | Dorsal | Anal | Pectoral | Pelvic |
| *Melamphaes* | 27-31 | III, 13-16 | I,7-9 | 14-17 | I,7 |
| *Poromitra* | 24-29 | III, 9-14 | I,8-11 | 13-15 | I,7-8 |
| *Scopeloberyx* | 23-27 | II-III, 10-13 | I,7-9 | 12-14 | I,7-8 |
| *Scopelogadus* | 24-26 | II, 10-12 | I,7-9 | 13-15 | I,7-8 |




Figures A–G, Keene and Tighe 1984 (B–G, North Atlantic specimens).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 28-X-31 |
| | Precaudal: 11-12-12 |
| | Caudal: 16-X-19 |
| **Branchiostegal rays** | 8-8-8 |
| **Caudal fin** | X, 10+9, X |
| **Pelvic fin** | Thoracic |
| | S: 1-1-1 R: 7-7-7 |
| **Dorsal fin** | S: 3-3-3 R: 14-15-16 |
| **Pectoral fin** | R: 15-16-17 |
| **Anal fin** | S: 1-1-1 R: 7-8-9 |
| **Gill rakers** | U: 5-X-6 L: 15-X-18 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Bering Sea, 54-66°N |
| **Ecology** | Mesopelagic, 200-1000 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS - Family

| | |
|---|---|
| **Diameter** | 0.81-0.96 mm SL |
| **No. of oil globules** | One to many |
| **Oil globule diameter** | |
| **Yolk** | Segmented |
| **Envelope** | Clear, spherical |
| **Hatch size** | Probably <2 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 45-55% SL |
| **Length at flexion** | ~6 mm SL |
| **Length at transformation** | |
| **Sequence of fin development** | Pelvics, dorsal and caudal, anal, pectorals |

**Pigment**

- Dorsally on top of head
- Peritoneum
- Postanal: Two spots near posterior of dorsal and anal anlagen which spread anteriorly and posteriorly along dorsal and ventral midline
- Spot on caudal peduncle

**Diagnostic characters**

- Pigment (see above): Patches, bands
- 2nd or 3rd dorsal ray elongate (until 5-10 mm SL)
- Pelvics: (2-10 mm SL) develop rapidly and are long, fragile, and pigmented

Distinguished from *Sebastolobus* spp. (p. 336) at sizes <5 mm SL by

- Postanal pigment band more anterior, beginning at myomere 15
- Precocious development of pelvic fin

*M. parvus* larvae are unknown. The following meristic information may aid in identification.

| | |
|---|---|
| Total vertebrae | 27-29 |
| Precaudal vertebrae | 11-12 |
| Caudal vertebrae | 16-17 |
| Dorsal fin rays | III, 13-15 |
| Anal fin rays | I, 7-9 |
| Pectoral fin rays | 14-15 |
| Pelvic fin rays | I, 7 |

Ref: Keene and Tighe 1984.

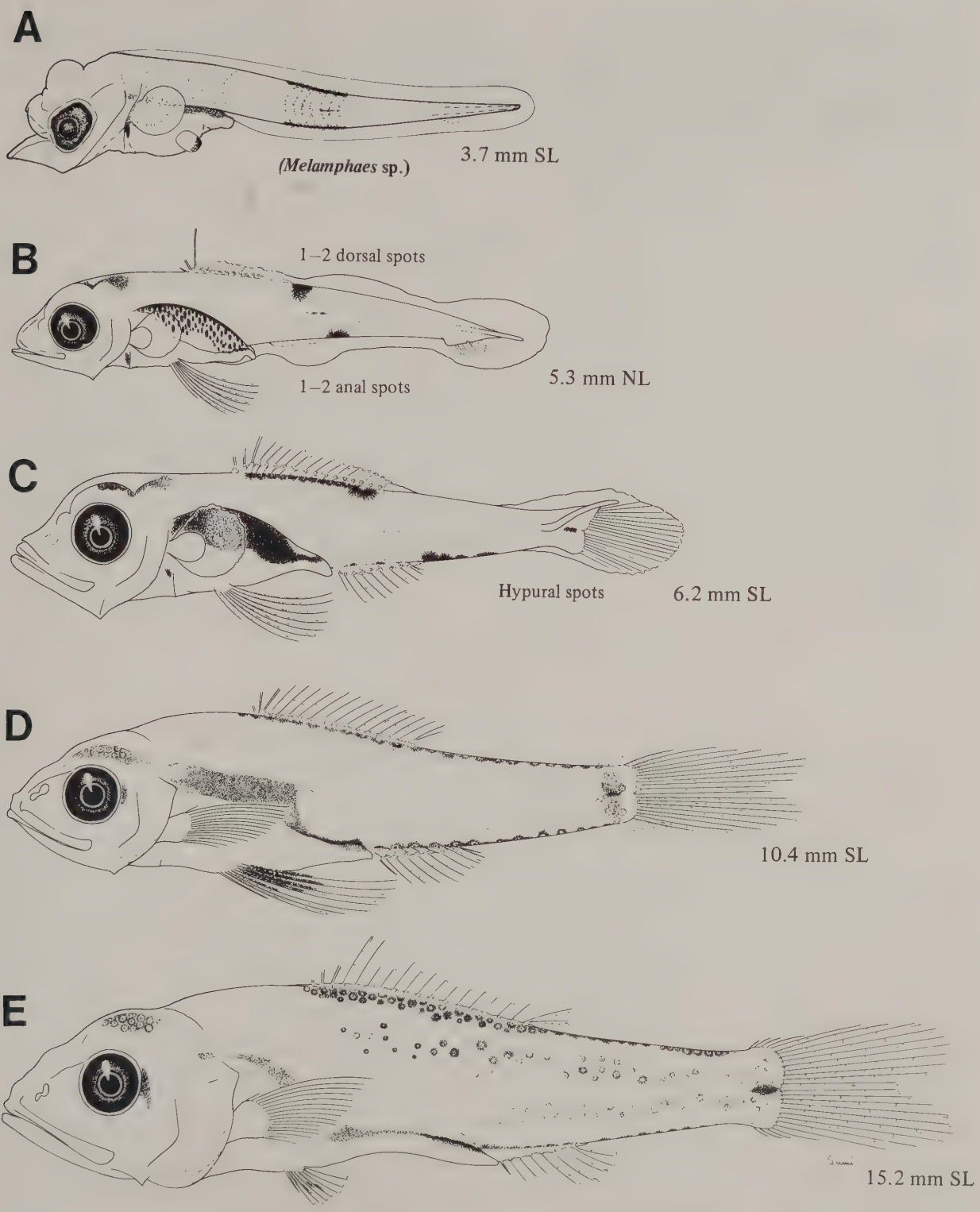



Figure A, NWAFC original (B. Vinter); B–E, Keene and Tighe 1984.

Fishes of the suborder Cetomimoidei are bathypelagic with whale-shaped bodies, large mouths, highly distensible stomachs, and luminous tissue on the body. Eyes may be reduced or rudimentary. Whalefishes are divided into three families: Cetomimidae, Rondeletiidae, and Barbourisiidae. Worldwide in distribution, the suborder consists of 8 genera and 18 species. Of these, five species in five genera have been collected in the northeastern Pacific. Adults are taken by deep tows generally in excess of 400 m, and then only rarely. No information on life history, eggs, or larvae is available (Keene and Tighe 1984).

**Table 28**
**Meristic characters of suborder Cetomimoidei.**

| Taxon | Distribution | Vertebrae | | Fins | | | | Gill rakers | | Branchiostegals |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Precaudal (Total) | Caudal | Dorsal | Anal | Pectoral | Pelvic | Upper | Lower | |
| **Barbourisiidae** | | (42-44) | | | | | | | | |
| *Barbourisia rufa* | Cent. Calif. - Arctic | 17-18 (42-44) | 25 | 20-22 | 16-18 | 13-14 | 6 | 4-6 | 14-16 | 6-7 |
| **Cetomimidae** | | (51-52) | | | | | | | | |
| *Cetomimus* sp. | Bering Sea | | | | | | | | | |
| *Cetostoma regani* | Cent. Calif. - Oregon | | | 30 | 27 | 14 | Absent | | | 8 |
| *Gyrinomimus* sp.* | N. Calif. - Brit. Col. | | | | | | | | | |
| **Rondeletiidae** | | (24-27) | | | | | | | | |
| *Rondeletia loricata* | S. Calif. - Oregon | 10 (24-26) | 16 | 13-16 | 13-14 | 9-11 | 5 | 4-6 | 14-16 | 8 |

*Peden et al. 1985.

## Zeiformes

The zeiforms occur in tropic and temperate areas of all oceans, in benthic and pelagic habitats from shallow to deep-water areas; little else is known of the life history of most fish in this group. Adults are generally deep-bodied with large eyes, greatly distensible jaws, and dorsal, anal and/or pelvic fin spines. The order is loosely organized according to a number of characters, none of which are unique. Presently, there are 6 families, 21 genera, and about 36 species throughout their distribution (J. Nelson 1984). The order is represented in the study area by one taxon, *Allocyttus* sp., a member of the Oreosomatidae. Eggs of only three species are known. Sizes range from 1.0 to 2.25 mm in diameter; all have a smooth chorion, homogeneous yolk, and a single oil globule (Tighe and Keene 1984). Larvae are generally deep-bodied and may be heavily pigmented. Forms exhibit a variety of armaments including serrated cranial ridges and spines, preopercular spines, and hardened cones or scaley knobs.

Family in study area: **Oreosomatidae**

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 39-39-40 | |
| | Precaudal: 13-X-14 | |
| | Caudal: 26-26-26 | |
| **Branchiostegal rays** | 7-7-7 | |
| **Caudal fin** | Total rays = 12-18 | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 6-6-6 |
| **Dorsal fin** | S: 6-X-7 | R: 30-X-36 |
| **Pectoral fin** | R: 19-X-21 | |
| **Anal fin** | S: 2-X-3 | R: 28-X-33 |
| **Gill rakers** | U: 6-6-6 | L: 18-X-21 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Cent. California, 34-38°N, to Bering Sea, 54-66°N |
| **Ecology** | Meso- and bathybenthal, 366-732 m |
| **ELH pattern** | Eggs and larvae unknown |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE[b]

**Preanal length**
**Length at flexion**
**Length at transformation**
**Sequence of fin development**
**Pigment**

**Diagnostic characters** - Family

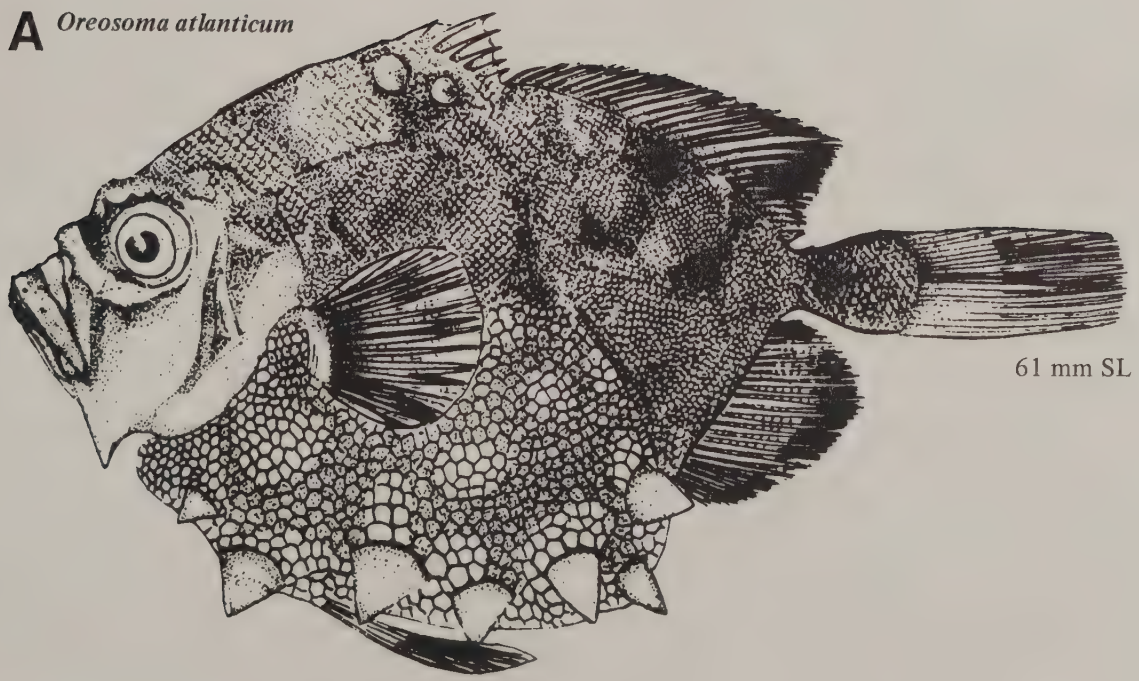
- Limited data on prejuveniles only; pelagic prejuveniles are oval in outline and possess a leathery skin with distinct hardened cones or scaly knobs laterally and ventrally

[a] *Allocyttus folletti* and *A. verrucosus* may occur in the study area, but identification to species is not possible. Kobayashi et al. (1968) suggested *A. folletti* should be a synonym of *A. verrucosus*.

[b] Early-life-history stages of *Allocyttus* spp. are unknown. An illustration of a prejuvenile of *Oreosoma atlanticum* is presented for comparison only. A photograph of an *Allocyttus verrucosus* juvenile (95 mm TL) is presented in Kobayashi et al. (1968).

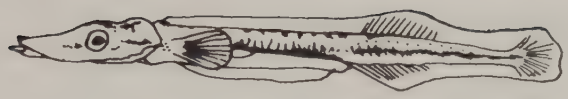
Ref: Kobayashi et al. 1968, Tighe and Keene 1984.

A *Oreosoma atlanticum*



61 mm SL

Figure A, Abe and Kaji 1972 (Tasman Sea specimen).



## Gasterosteiformes

The order Gasterosteiformes is made up of small, cryptically colored fish found in freshwater or marine habitats in tropical and temperate areas. Most species have small mouths at the end of tubular snouts and dermal plates covering the body. Historically divided into two or three orders, the group, as supported by Pietsch (1978) and Fritzsche (1984), contains 10 families with well over 200 species. Eggs are broadcast or deposited in nests or on algae, or for syngnathids, in male brood pouches. Eggs of families other than Syngnathidae are 1.5-2.1 mm in diameter, may have one or more oil globules, and have thick chorions. Most gasterosteiform larvae hatching from externally incubated eggs (except gasterosteids) have the same distinctive characters (i.e., elongate snout and small mouth, dermal plates) as the adults. Although adult gasterosteids are sometimes collected in plankton samples, early-life-history stages are unlikely to occur and are not treated here.

Families in study area: **Aulorhynchidae**
**Gasterosteidae**
**Syngnathidae**

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 54-54-56 | |
| | Precaudal: 24-25-26 | |
| | Caudal: 29-29-31 | |
| **Branchiostegal rays** | 4-4-4 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 4-4-4 |
| **Dorsal fin** | S: 23-X-27 | R: 9-X-11 |
| **Pectoral fin** | R: X-X-X | |
| **Anal fin** | S: 1-1-1 | R: 9-X-10 |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to SE Alaska, 55-59°N |
| **Ecology** | Nearshore shelf pelagic |
| **ELH pattern** | Oviparous; demersal, adhesive, guarded eggs; larvae briefly pelagic |
| **Spawning** | Season: Late spring-summer (Brit. Col.);[a] Feb-July (Calif.);[b] year-round (Calif.)[c]<br>Area: Demersal, on algae or marine plants[a]<br>Mode: Nest building; males territorial, polygamous[c]<br>Migration: |
| **Fecundity** | Range/function: 150-600/mass[a] |
| **Age at first maturity** | 1 yr[c] |
| **Longevity** | 9 yr[b] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 2.0-2.1 mm |
| **No. of oil globules** | One |
| **Oil globule diameter** | |
| **Yolk** | Yellow to yellow-green |
| **Envelope** | Thick |
| **Hatch size** | 8 mm TL |
| **Incubation time/temp.** | 2-6 wk/10°C |
| **Pigment** | |

**Diagnostic characters**

- Protracted hatch always occurs, embryos develop asynchronously

### LARVAE

| | |
|---|---|
| **Preanal length** | 60-65% SL |
| **Length at flexion** | >16 mm TL |
| **Length at transformation** | |
| **Sequence of fin development** | Pectorals; dorsal rays, anal, and caudal; dorsal spines; pelvics |

**Pigment**

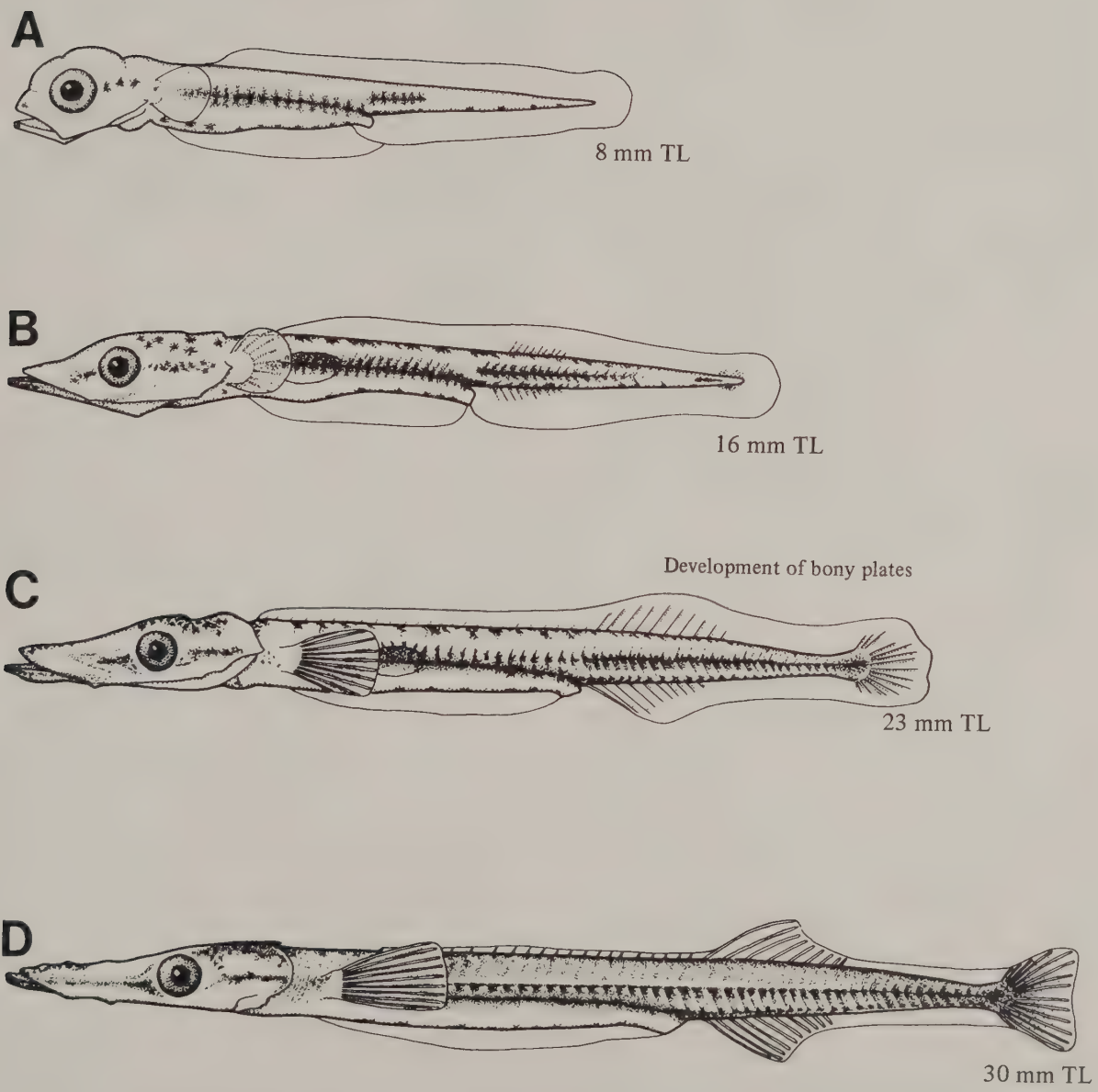
- Gut: Along dorsal surface and ventral midline
- Postanal body: Dorsal and ventral midline to tail; along notochord initially over anal fin but increasing anteriorly
- Head: Dorsal and posterior to eye

**Diagnostic characters**

- Pigment generally heavier than on syngnathids
- Bony plates develop by notochord flexion
- Elongated snout

[a] Marliave 1975a
[b] Fitch and Lavenberg 1975
[c] Limbaugh 1962

Ref: Fritzsche 1984, Ida 1976, Limbaugh 1962, Marliave 1976.




Figures A–D, Marliave 1976.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 56-61-64 |
| | Precaudal: 19-20-21 |
| | Caudal: 37-41-43 |
| **Branchiostegal rays** | 2-X-3 |
| **Caudal fin** | |
| **Pelvic fin** | Absent |
| **Dorsal fin** | R: 28-38-43 |
| **Pectoral fin** | R: 11-X-13 |
| **Anal fin** | R: 2-X-3 |
| **Gill rakers** | U: X-X-X L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to SE Alaska, 55-59°N |
| **Ecology** | Intertidal, nearshore |
| **ELH pattern** | Oviparous, eggs and larvae develop in brood pouch |
| **Spawning** | Season: Spring-summer[a] |
| | Area: Inshore protected areas[b] |
| | Mode: Males retain eggs and developing larvae until the young have reached a juvenile stage of development[b] |
| | Migration: |
| **Fecundity** | Range/function: 225[a] |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.0-1.5 mm |
| **No. of oil globules** | One or more |
| **Oil globule diameter** | 0.4-0.5 mm |
| **Yolk** | Bright yellow |
| **Envelope** | |
| **Hatch size** | 4.5-5.0 mm TL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE[c]

| | |
|---|---|
| **Preanal length** | 35-40% TL |
| **Length at flexion** | |
| **Length at transformation** | |
| **Sequence of fin development** | |

**Pigment**

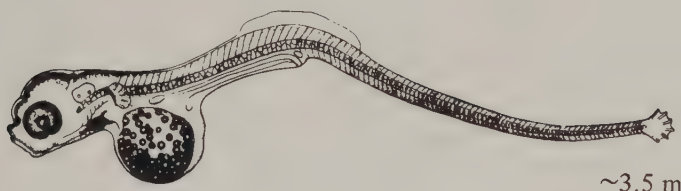
- Sparse at hatching, developing to form vertical blotches covering the head and body

**Diagnostic characters**

[a] Wang 1981
[b] Hart 1973
[c] Larval illustrations of *Syngnathus leptorhynchus* are unavailable. Illustrations of early-life-history stages of other members of the genus are presented for comparison and may differ from early-life-history stages of *S. leptorhynchus*.

Ref: Wang 1981.

**A** *Syngnathus fuscus*



~3.5 mm TL

**B** *Syngnathus schlegeli*

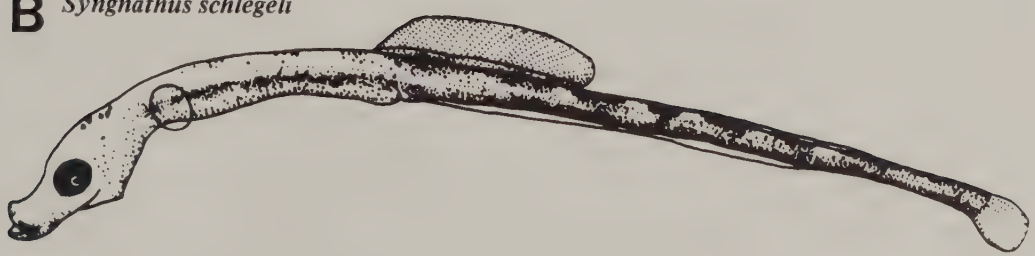
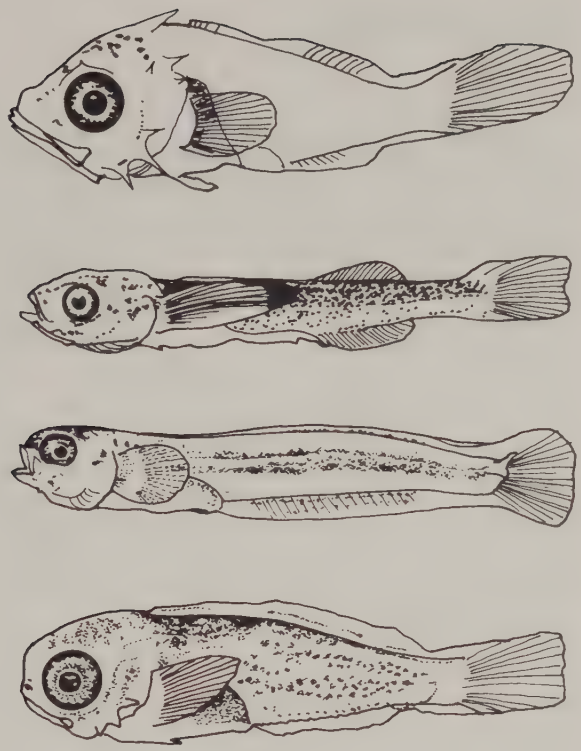


Figure A, Ryder 1887 (reversed, Atlantic specimen from brooding pouch); B, Chung 1977 (western Pacific specimen).



## Scorpaeniformes

Most scorpaeniforms are bottom-oriented and have large heads, large rounded pectoral fins, rounded caudal fins, and many have head spines or bony plates (or combinations thereof). One character unites the group: a bony suborbital stay extending from the third suborbital bone to the opercle. Within the Scorpaeniformes, there are 20 families, 269 genera, and about 1160 species (J. Nelson 1984). The order is usually divided into four suborders: Scorpaenoidei, Anoplopomatoidei, Hexagrammoidei, and Cottoidei. Although members of the order are distributed worldwide, more than 250 species occur in the North Pacific Ocean and Bering Sea of which 190 are endemic.

Reproduction is oviparous except in *Sebastes* where eggs are internally fertilized and live feeding young are extruded. Larvae are extremely diverse. Head spines are common in larval scorpaenoids and cottoids.

Families in study area: **Scorpaenidae**
**Anoplopomatidae**
**Hexagrammidae**
**Cottidae**
**Agonidae**
**Cyclopteridae**

### Scorpaenidae

In the study area this speciose family consists of *Sebastes*, with about 40 species, and *Sebastolobus* with 3 species. The larvae can be identified to genus, but identification is presently possible for only a few of the species of *Sebastes*. Information is included here which will aid in identifying species for which early-life-history series are known, and also characters are presented which may prove useful in identifying species whose larvae are not yet known. Full text pages are provided for those species for which an illustration is available of a postflexion larva and at least one other stage. Species with illustrations of only an extrusion larva or pelagic juvenile are treated in the comparative sections. For *Sebastes* species accounts, a section on head spines has been substituted for the egg section, and counts of lateral line pores and total gill rakers have been added to the meristic section.

### Sebastinae

Among the 70 or so species of *Sebastes* in the Northeast Pacific, 40 species are known to occur in the study area (Table 29). Meristic information on the following pages has been updated from recent sources (Chen 1986; Laroche, in prep.). *Sebastes* are ovoviviparous (or viviparous[1]) and give birth to live young which are similar in stage of development to first-feeding larvae of oviparous scorpaenids. Eggs, generally between 0.75 and 1.9 mm diameter, are retained in the lumen of the ovary after ovulation and internal fertilization. Eggs possess a homogeneous yolk, narrow perivitelline space, fragile smooth chorion, and one to many oil globules. Hatching precedes extrusion with newborn larvae, 3.8-7.5 mm SL, having already utilized most of their yolk.

Newly extruded larvae have functional eyes, jaws, and pectoral fins. Notochord flexion occurs at about 6-12 mm SL and transformation (acquisition of adult complement of fin rays) occurs at about 15-25 mm SL. Many species have a distinct pelagic juvenile stage that may last until about 60 mm SL. Preflexion larvae have relatively slender bodies and compact guts (13-23% SL). Snout-to-anus length may increase from 40-50% SL to >60% SL in some species during the larval period. Preflexion larvae usually have pigment over the gut and a series of postanal ventral melanophores. Some species may have pigment along the dorsal midline which develops gradually. Other pigment may occur on the brain, jaws, opercle, fins (especially pectorals), and caudal peduncle.

A prominent feature in *Sebastes* larvae is head spination. Pterotic, parietal, and preopercular spines form before larvae undergo flexion, and other spines appear gradually thereafter. The full complement of head spines generally develops during the larval period, and some spines that develop in the larval period (e.g., pterotic, anterior preopercles, and lower post-temporal, and others in some) are overgrown during the juvenile stage (Washington et al. 1984b).

Larval series of 16 species of *Sebastes* occurring in our study area are known. Extrusion or yolk-exhaustion larvae have been illustrated for 32 species, and pelagic juveniles have been illustrated for 33 species. Although *Sebastes* larvae are often abundant in plankton samples from the Northeast Pacific in winter and spring, the specific identity of most cannot presently be determined.

### Sebastolobinae

*Sebastolobus* is represented by three species in the study area. Eggs are extruded in bilobed gelatinous masses which float at the surface. The eggs are slightly elliptical and have homogeneous yolk, a narrow perivitelline space, and a smooth chorion. A single oil globule (0.18-0.20 mm diameter) is present (Pearcy 1962, Moser 1974).

Besides differences in meristic characters, *Sebastolobus* larvae can be distinguished from those of *Sebastes* in that preflexion larvae have a postanal band of pigment instead of the ventral and possibly dorsal midline melanophores in *Sebastes*. A parietal ridge develops in *Sebastolobus* and terminates in a double spine, the parietal and nuchal. In *Sebastes* the parietal spine develops singly, usually with a smaller nuchal spine immediately posterior to it.

[1]Boehlert and Yoklavich (1984) demonstrated that in *Sebastes melanops* the embryos receive some nutrition from the ovarian fluid during gestation.

## Table 29

**Distribution, parturition season, and meristic characters of genus *Sebastes*. Range of counts followed by mode in parentheses. All have modal counts of 13 dorsal spines (except *S. polyspinis* with 14[a]) and 3 anal spines (Chen 1986).**

| Taxon | Distribution | Parturition | Fin rays | | | Total gill rakers on first arch | No. of lateral line pores |
|---|---|---|---|---|---|---|---|
| | | | Dorsal | Anal | Pectoral | | |
| *S. aleutianus* | S. Calif.-Bering Sea | Apr[b] | 13-15 (14) | 7-8 (7) | 17-19 (18) | 28-33 (31) | 30-33 |
| *S. alutus* | S. Calif.-Bering Sea | Jan-May[c] | 13-16 (15) | 7-9 (8) | 17-19 (18) | 34-39 (35/38) | 46-55 |
| *S. auriculatus* | SSC-SE Alaska | Mar-June[d] | 12-14 (13) | 6-7 (7) | 16-19 (18) | 25-29 (27) | 42-50 |
| *S. aurora* | S. Calif.-Brit. Col. | Mar-May[e] | 12-13 (13) | 5-7 (6) | 17-19 (17) | 24-28 (27) | 28-31 |
| *S. babcocki* | S. Calif.-Bering Sea | Apr-May[b] | 13-15 (14) | 6-8 (7) | 17-20 (19) | 29-33 (31) | 42-51 |
| *S. borealis* | Cent. Calif.-Bering Sea | Apr[c] | 12-15 (13) | 6-8 (7) | 17-20 (19) | 27-31 (30) | 28-32 |
| *S. brevispinis* | SSC-Bering Sea | June[b], June-July[c] | 13-15 (14) | 7-7 (7) | 17-18 (18) | 33-36 (33) | 46-51 |
| *S. caurinus* | SSC-Gulf of Alaska | Apr[b] | 11-14 (13) | 5-7 (6) | 16-18 (17) | 26-31 (28) | 39-47 |
| *S. chlorostictus* | SSC-Wash. | July[f] | 11-13 (12) | 5-7 (6) | 16-18 (17) | 31-36 (33) | 35-43 |
| *S. ciliatus* | Brit. Col.-Bering Sea | | 14-16 (15) | 6-9 (8) | 17-19 (18) | 32-35 (35) | 42-53 |
| *S. crameri* | S. Calif.-Bering Sea | Feb[c] | 13-15 (13) | 7-7 (7) | 18-20 (19) | 30-34 (32) | 40-51 |
| *S. diploproa* | SSC-Gulf of Alaska | May-June[b], July[c] | 11-14 (12) | 5-7 (7) | 17-18 (18) | 32-37 (34) | 32-42 |
| *S. elongatus* | SSC-Gulf of Alaska | May-June[b] | 12-14 (13) | 6-7 (6) | 16-18 (17) | 29-33 (31) | 37-47 |
| *S. emphaeus* | N. Calif.-Gulf of Alaska | Aug-Sept[g] | 13-15 (14) | 6-7 (7) | 16-18 (17) | 37-41 (40) | 40-46 |
| *S. entomelas* | SSC-Gulf of Alaska | Apr[c], Nov-Mar[h] | 14-16 (15) | 7-9 (8) | 18-19 (18) | 34-38 (36) | 54-60 |
| *S. flavidus* | S. Calif.-Gulf of Alaska | Mar[c], Nov-Feb[h] | 14-15 (14) | 7-8 (8) | 17-18 (18) | 34-37 (36) | 49-55 |
| *S. glaucus* | Bering Sea | | 14-17 (15) | 7-9 (8) | 18-20 (19) | 35-41 (38) | |
| *S. goodei* | SSC-Brit. Col. | Dec-Mar[h] | 13-14 (14) | 8-9 (8) | 16-18 (17) | 34-39 (36) | 50-57 |
| *S. helvomaculatus* | SSC-Gulf of Alaska | June[c] | 12-14 (13) | 6-7 (6) | 15-17 (16) | 28-33 (30) | 34-45 |
| *S. jordani* | SSC-Gulf of Alaska | Mar[c], Nov-Mar[h] | 13-16 (14) | 9-10 (9) | 19-22 (20) | 40-47 (44) | 53-64 |
| *S. maliger* | Cent. Calif.-Gulf of Alaska | Apr[c] | 11-13 (13) | 6-7 (7) | 16-18 (17) | 29-33 (31) | 34-45 |
| *S. melanops* | Cent. Calif.-Aleutian Is. | Apr[b] | 14-15 (15) | 7-9 (8) | 18-19 (19) | 34-38 (37) | 47-55 |
| *S. melanostictus* | Bering Sea | | 13-14 (14) | 7-7 (7) | 18-18 (18) | 32-35 (33) | |
| *S. melanostomus* | SSC-Wash. | | 12-14 (13) | 6-8 (7) | 18-20 (19) | 30-34 (31) | 28-33 |
| *S. miniatus* | SSC-Brit. Col. | Nov-Mar[h] | 13-15 (14) | 6-7 (7) | 17-18 (18) | 36-42 (41) | 41-48 |
| *S. mystinus* | SSC-Aleutian Is. | Nov-Jan[i] | 15-17 (16) | 8-10 (9) | 17-19 (18) | 32-38 (35) | 47-53 |
| *S. nebulosus* | S. Calif.-SE Alaska | | 12-14 (13) | 6-7 (7) | 17-18 (18) | 27-31 (28) | 38-43 |
| *S. nigrocinctus* | Cent. Calif.-SE Alaska | May[c] | 12-15 (14) | 6-7 (7) | 18-19 (19) | 28-32 (28) | 36-46[k] |
| *S. paucispinis* | SSC-Gulf of Alaska | Jan-Feb[c], Nov-Apr[j] | 13-15 (14) | 8-10 (9) | 14-16 (15) | 27-32 (28) | 51-62 |
| *S. pinniger* | SSC-Gulf of Alaska | Jan-Mar[c], Nov-Mar[f] | 13-15 (14) | 7-7 (7) | 16-18 (17) | 41-44 (43) | 40-47 |
| *S. polyspinis* | Brit. Col.-Bering Sea | | 13-16 (15) | 7-9 (8) | 17-19 (18) | 35-39 (36) | 43-53 |
| *S. proriger* | S. Calif.-Bering Sea | July[c] | 14-15 (15) | 7-7 (7) | 16-17 (17) | 36-41 (38) | 48-55 |
| *S. rastrelliger* | SSC-Oregon | | 12-13 (13) | 6-6 (6) | 18-20 (19) | 17-25 (23) | 40-49 |
| *S. reedi* | N. Calif.-SE Alaska | Apr[c] | 13-15 (14) | 7-8 (7) | 18-20 (19) | 30-36 (34) | 47-55 |
| *S. ruberrimus* | SSC-Gulf of Alaska | June[b], July[c] | 14-16 (15) | 7-7 (7) | 18-19 (19) | 26-30 (29/30) | 39-45 |
| *S. rufus* | SSC-Oregon | Dec-May[e] | 13-16 (15) | 8-9 | 17-19 (18) | 32-37 (35) | 49-56 |
| *S. saxicola* | SSC-Gulf of Alaska | Feb[c], Nov-Mar[h] | 11-13 (12) | 6-7 (7) | 16-18 (16) | 30-35 (32) | 35-43 |
| *S. variegatus* | Brit. Col.-Gulf of Alaska | June[c] | 14-15 (14) | 6-7 (7) | 17-19 (18) | 37-41 (38) | 43-52 |
| *S. wilsoni* | S. Calif.-Gulf of Alaska | June[c] | 13-15 (14) | 5-6 (6) | 16-18 (17) | 37-42 (39) | 37-46 |
| *S. zacentrus* | S. Calif.-Gulf of Alaska | July[c] | 13-15 (14) | 7-8 (7) | 16-18 (17) | 33-37 (35) | 39-47 |

[a] Incorrectly reported as 13 instead of 14 in Chen (1986:Table 2). L.-C. Chen, Dep. Zool., San Diego St. Univ., San Diego, CA 92192, pers. commun., 21 July 1988.
[b] Off Canada (Hart 1973).
[c] Off Canada (Westrheim 1975).
[d] Puget Sound (Washington et al. 1978).
[e] North-central California (Wyllie Echeverria 1987).
[f] Off California (Moser 1967).
[g] Puget Sound (Moulton 1975).
[h] Off north-central California (Phillips 1964).
[i] Off California (Wales 1952).
[j] Off California (Frey 1971).
[k] One rare count of 50.

### Head spines

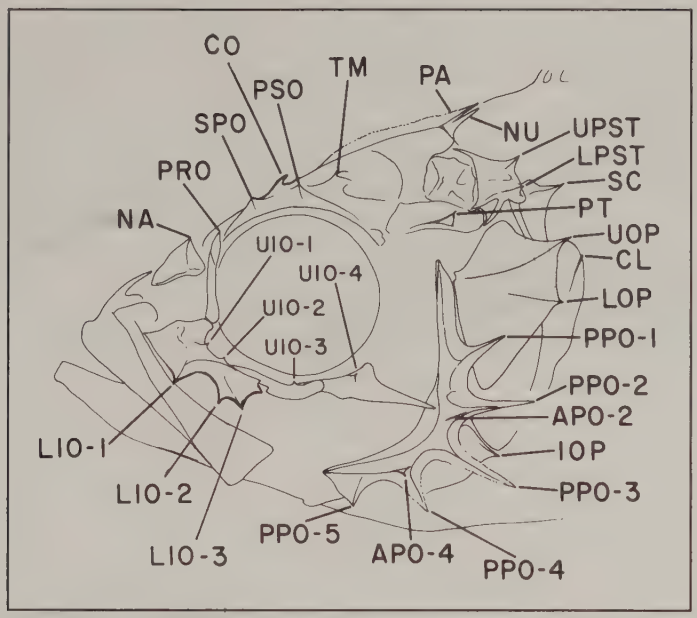
There are differences in terminology for *Sebastes* head spines between the two major sources of early-life-history descriptions (i.e., Richardson and Laroche 1979, Moser and Ahlstrom 1978). Most of the differences are semantic; however, the numbering of anterior preopercular spines is a substantive difference (Table 30). Among the species studied to date, posterior preopercular spine 1 has not had an anterior spine associated with it. Therefore, Richardson and Laroche (1979) gave the number 1 to the anterior preopercular spine associated with the second posterior preopercular spine. Moser and Ahlstrom (1978) gave the same numbers to the anterior and posterior preopercular spines. Thus the same anterior preopercular spine is numbered one less by Richardson and Laroche (1979) than it is by Moser and Ahlstrom (1978). Succeeding descriptions by these and other authors perpetuate these differences (e.g., Washington et al. 1984b). Here we use the system of Moser and Ahlstrom (1978).

There are also differences between the *Sebastes* head spine terminology used for adults and that used for larvae (Table 30). This situation resulted from the difficulty of determining spine/bone associations by external examination of adults and is complicated by the overgrowth of some spines during development (Richardson and Laroche 1979). The major points of confusion are that the supracleithral of larvae is called the upper posttemporal spine of adults, and the cleithral spine of larvae is called the supracleithral spine of adults. Head spine patterns which may help identify adult *Sebastes* are listed in Table 31.

**Table 30**

**Head spine terminology in *Sebastes*, listed by sequence in which the spines develop in *S. melanostomus* (Moser and Ahlstrom 1978). Names used by Richardson and Laroche (1979) are listed only when they differ from those used by Moser and Ahlstrom (1978).**

| Abbreviation | Moser and Ahlstrom (1978) | Richardson and Laroche (1979) | Bone of origin | Adult spine |
|---|---|---|---|---|
| **PA** | Parietal | | Parietal | Parietal |
| **NU** | Nuchal | | Parietal | Nuchal |
| **PSO** | Postocular | | Frontal | Postocular |
| **PT** | Pterotic | | Pterotic | (Overgrown) |
| **LPST** | Lower posttemporal | Inferior posttemporal | Posttemporal | (Overgrown) |
| **UOP** | Upper opercular | Superior opercular | Opercle | Opercular |
| **UIO-1** | 1st upper infraorbital | Superior infraorbital series, 1st | Infraorbital 1 | (Overgrown) |
| **LIO-1** | 1st lower infraorbital | Inferior infraorbital series, 1st | Infraorbital 1 | Lachrymal projection (suborbital spine) |
| **APO-2** | 2nd anterior preopercular | Anterior preopercular series, 1st | Preopercle | (Overgrown) |
| **PPO-2** | 2nd posterior preopercular | Posterior preopercular series, 2nd | Preopercle | Preopercular |
| **APO-3** | 3rd anterior preopercular | Anterior preopercular series, 2nd | Preopercle | (Overgrown) |
| **PPO-3** | 3rd posterior preopercular | Posterior preopercular series, 3rd | Preopercle | Preopercular |
| **APO-4** | 4th anterior preopercular | Anterior preopercular series, 3rd | Preopercle | (Overgrown) |
| **PPO-4** | 4th posterior preopercular | Posterior preopercular series, 4th | Preopercle | Preopercular |
| **PPO-1** | 1st posterior preopercular | Posterior preopercular series, 1st | Preopercle | Preopercular |
| **PPO-5** | 5th posterior preopercular | Posterior preopercular series, 5th | Preopercle | Preopercular |
| **UIO-4** | 4th upper infraorbital | Superior infraorbital series, 4th | Infraorbital 3 | (Overgrown) |
| **SC** | Supracleithral | | Supracleithrum | Cleithral |
| **LIO-2** | 2nd lower infraorbital | Inferior infraorbital series, 2nd | Infraorbital 1 | Lachrymal projection (suborbital spine) |
| **LIO-3** | | Inferior infraorbital series, 3rd | Infraorbital 1 | (Overgrown) |
| **LOP** | Lower opercular | Inferior opercular | Opercle | Opercular |
| **UIO-2** | 2nd upper infraorbital | Superior infraorbital series, 2nd | Infraorbital 1 | (Overgrown) |
| **UPST** | Upper posttemporal | Superior posttemporal | Posttemporal | Supracleithral |
| **SPO** | Supraocular | | Frontal | Supraocular |
| **UIO-3** | 3rd upper infraorbital | Superior infraorbital series, 3rd | Infraorbital 2 | (Overgrown) |
| **NA** | Nasal | | Nasal | Nasal |
| **PRO** | Preocular | | Lateral ethmoid (prefrontal) | Preocular |
| **CL** | Cleithral | | Cleithrum | (Overgrown) |
| **IOP** | Interopercular | | Interopercular (interopercle) | Gill cover spine |
| **TM** | Tympanic | | Frontal | Tympanic |
| **SOP** | Subopercular | | Subopercular (subopercle) | Gill cover spine |
| **CO** | Coronal | | Frontal | Coronal |




**Positions and abbreviations of larval head spines in larval *Sebastes*. Based on a 16.0-mm stained larva of *Sebastes melanostomus* augmented to show the position of the coronal (CO) and 3rd lower infraorbital (LI0-3) spines. From Moser and Ahlstrom (1978) and Laroche (in prep.).**

## Table 31

**Presence and absence of head spines which are diagnostic for adults of members of the genus *Sebastes* (+ indicates presence, 0 indicates absence, blank indicates unknown character state).**

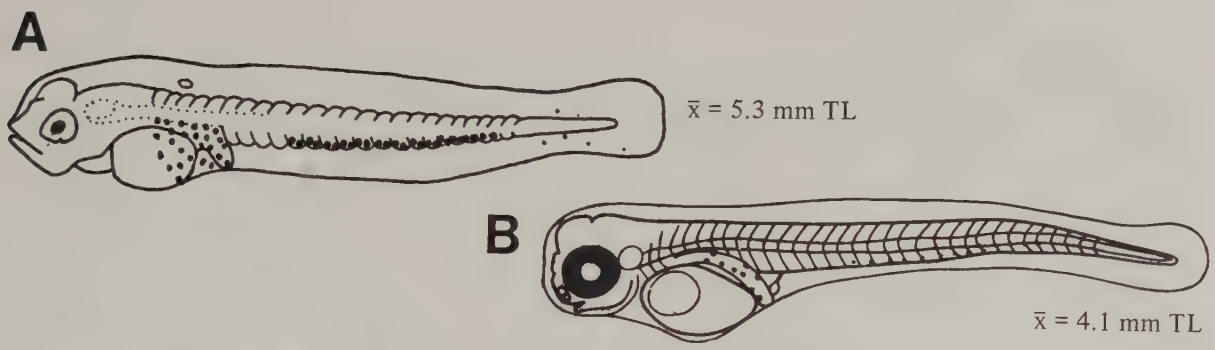
| | Pre-ocular | Supra-ocular | Post-ocular | Tympanic | Coronal | | Pre-ocular | Supra-ocular | Post-ocular | Tympanic | Coronal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *S. aleutianus* | + | + | + | + | + | *S. maliger* | + | 0 | + | + | 0 |
| *S. alutus* | + | + | + | + | 0 | *S. melanops* | 0 | 0 | + | + | 0 |
| *S. auriculatus* | + | 0 | + | + | + | *S. melanostictus* | | | + | + | |
| *S. aurora* | + | + | + | + | 0 | *S. melanostomus* | + | + | + | + | 0 |
| *S. babcocki* | + | 0 | + | + | 0 | *S. miniatus* | + | + | + | + | 0 |
| *S. borealis* | + | + | + | + | + | *S. mystinus* | + | + | + | + | 0 |
| *S. brevispinis* | 0 | 0 | + | + | 0 | *S. nebulosus* | + | 0 | + | + | 0 |
| *S. caurinus* | + | 0 | + | + | 0 | *S. nigrocinctus* | + | 0 | + | + | + |
| *S. chlorostictus* | + | + | + | + | 0 | *S. paucispinis* | + | 0 | 0 | + | 0 |
| *S. ciliatus* | 0 | + | + | + | 0 | *S. pinniger* | + | + | + | + | 0 |
| *S. crameri* | + | + | + | + | 0 | *S. polyspinis* | 0 | 0 | + | + | 0 |
| *S. diploproa* | + | 0 | + | + | 0 | *S. proriger* | + | 0 | + | + | 0 |
| *S. elongatus* | + | 0 | + | + | 0 | *S. rastrelliger* | + | 0 | + | + | 0 |
| *S. emphaeus* | + | 0 | + | + | 0 | *S. reedi* | + | + | + | + | 0 |
| *S. entomelas* | + | + | + | + | 0 | *S. ruberrimus* | + | + | + | + | 0 |
| *S. flavidus* | 0 | 0 | + | + | 0 | *S. rufus* | | | + | + | 0 |
| *S. glaucus* | | | + | + | 0 | *S. saxicola* | + | 0 | + | + | 0 |
| *S. goodei* | 0 | 0 | + | 0 | 0 | *S. variegatus* | + | 0 | + | + | 0 |
| *S. helvomaculatus* | + | + | + | + | 0 | *S. wilsoni* | + | 0 | + | + | 0 |
| *S. jordani* | + | 0 | + | + | 0 | *S. zacentrus* | + | 0 | + | + | 0 |

**Extrusion or Yolk-Exhaustion Larvae**

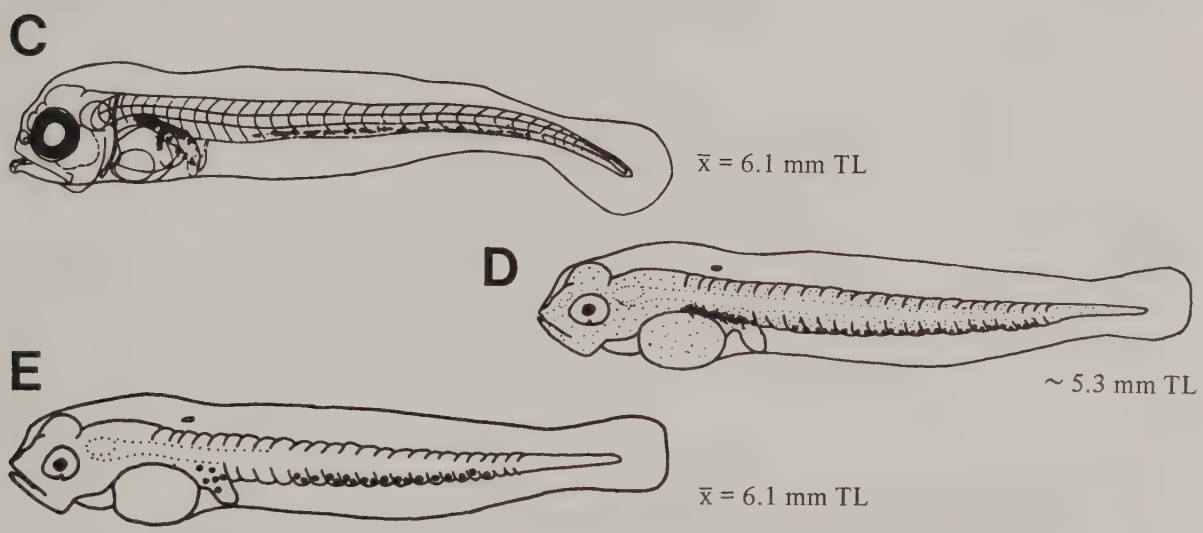
Various authors have illustrated and described larvae which have been extruded from pregnant female *Sebastes*. In some cases, the larvae have been maintained in seawater for several days after extrusion, and in a few cases (e.g., Stahl-Johnson 1985, Moser and Butler 1987) the larvae were fed and reared. With handling, pregnant *Sebastes* will release larvae that are not full-term, and such larvae may be represented in some illustrations. Furthermore, some illustrations were drawn by adding observed pigmentation for a particular species to a general outline of an extrusion *Sebastes* larva (c.f. Westrheim et al. 1968a). The generalized outline used by Westrheim et al. (e.g., 1968a) and DeLacy et al. (1964) lacked pectoral fins, apparently the result of an oversight. Several illustrations of extrusion larvae have been published for some species, and there are notable differences among some of these illustrations. One of the illustrations of an extrusion larva purported to be *Sebastes zacentrus* by Harling et al. (1971) was obviously misidentified, as discussed by Laroche and Richardson (1981). With these problems in mind, pages 273-280 present all of the published, and some previously unpublished, illustrations of extrusion larvae of *Sebastes* spp. which occur in the study area, not so much for use in species identifications but as reference for further research.

EXTRUSION OR YOLK-EXHAUSTION LARVAE

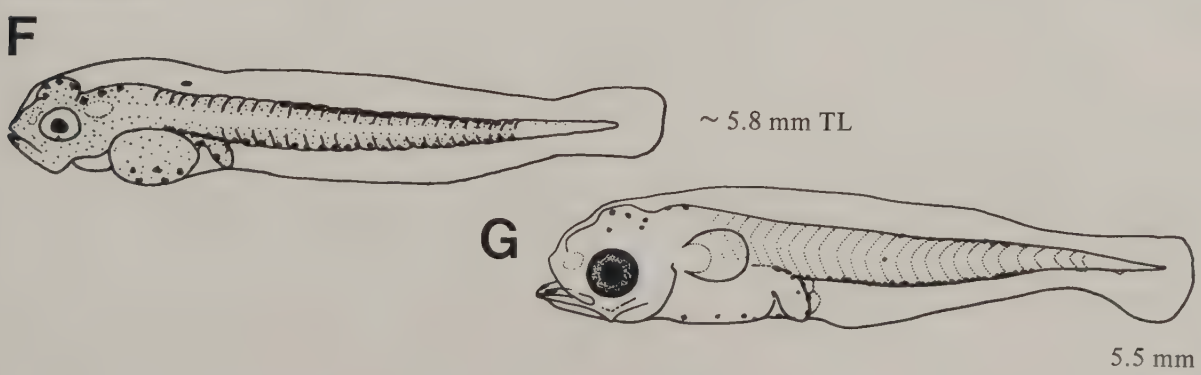
*S. aleutianus*




*S. alutus*




*S. auriculatus*




Figures A, E, Westrheim et al. 1968a; B–C, Efremenko and Lisovenko 1970; D, F, DeLacy et al. 1964; G, Moser et al. 1977.

EXTRUSION OR YOLK-EXHAUSTION LARVAE

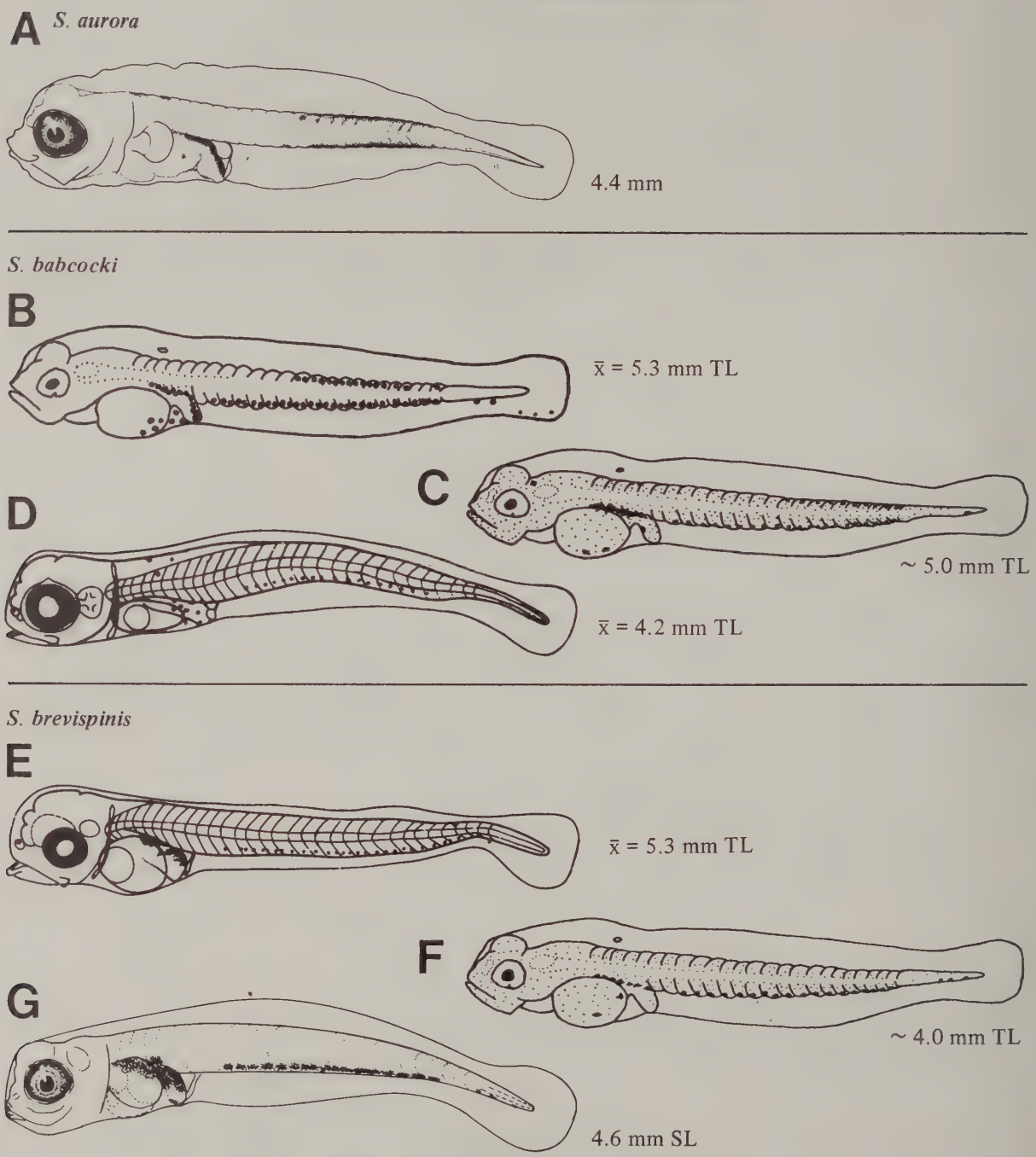
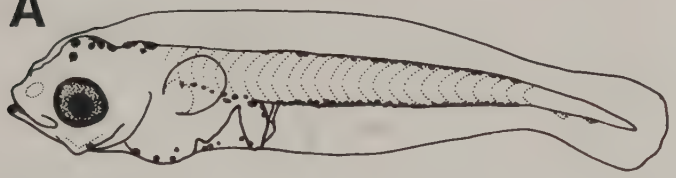



Figure A, Moser et al. 1985; B, Westrheim et al. 1968a; C, F, DeLacy et al. 1964; D, E, Efremenko and Lisovenko 1970; G, NWAFC original (B. Vinter).

## EXTRUSION OR YOLK-EXHAUSTION LARVAE

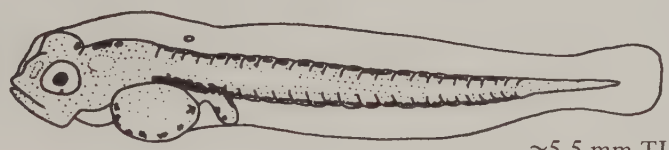
*S. caurinus*

A



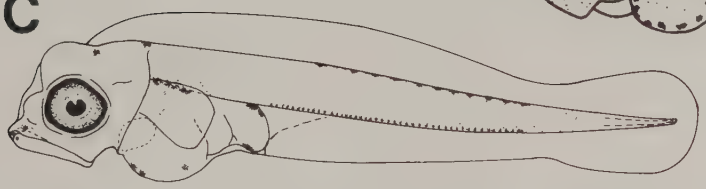
5.2 mm

B



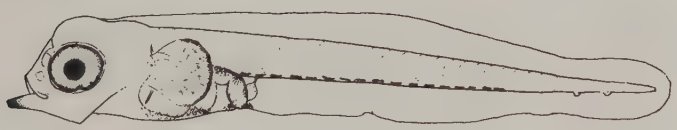
~5.5 mm TL

C



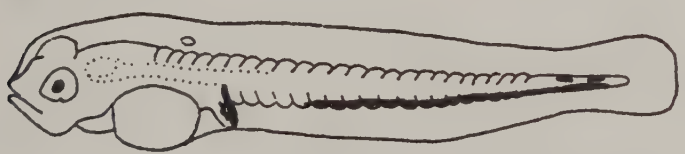
~ 5.1 mm SL

D *S. chlorostictus*



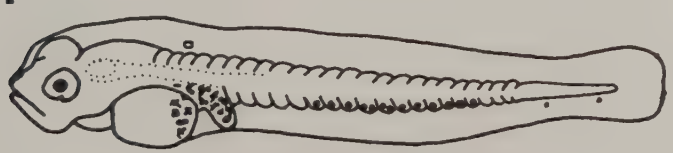
4.2 mm

E *S. ciliatus*



$\bar{x}$ = 5.8 mm TL

F *S. crameri*

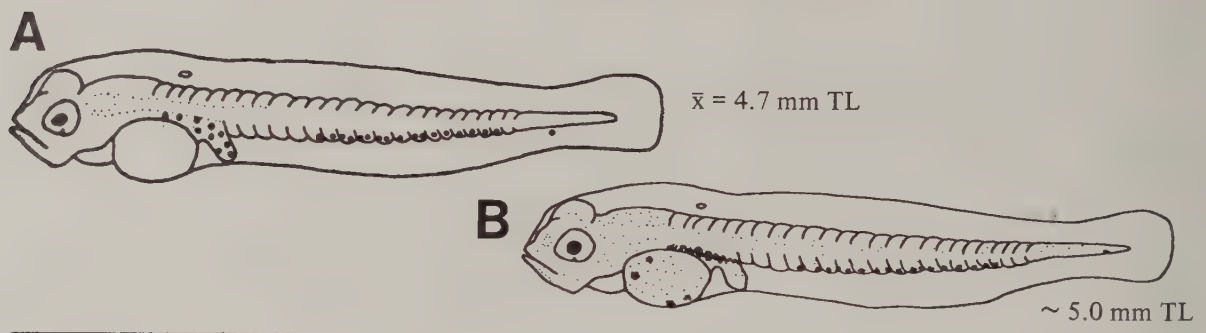


$\bar{x}$ = 5.9 mm TL

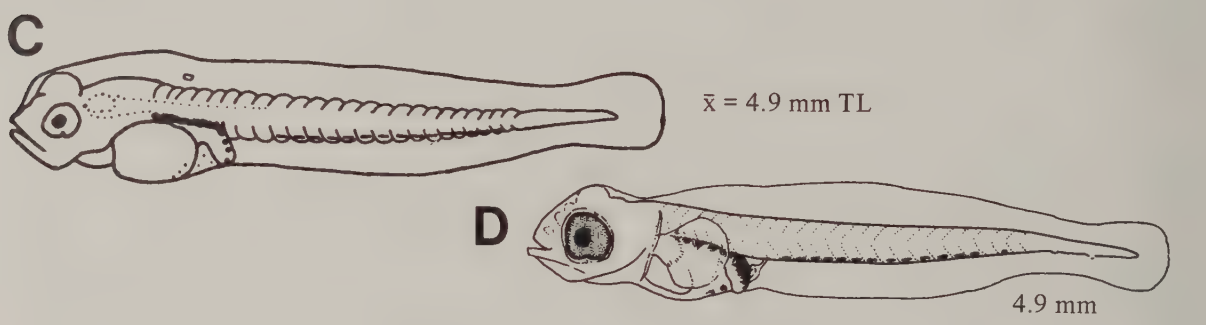
Figures A, D, Moser et al. 1977; B, DeLacy et al. 1964; C, NWAFC original (B. Vinter); E, Harling et al. 1971; F, Westrheim et al. 1968a.

## EXTRUSION OR YOLK-EXHAUSTION LARVAE

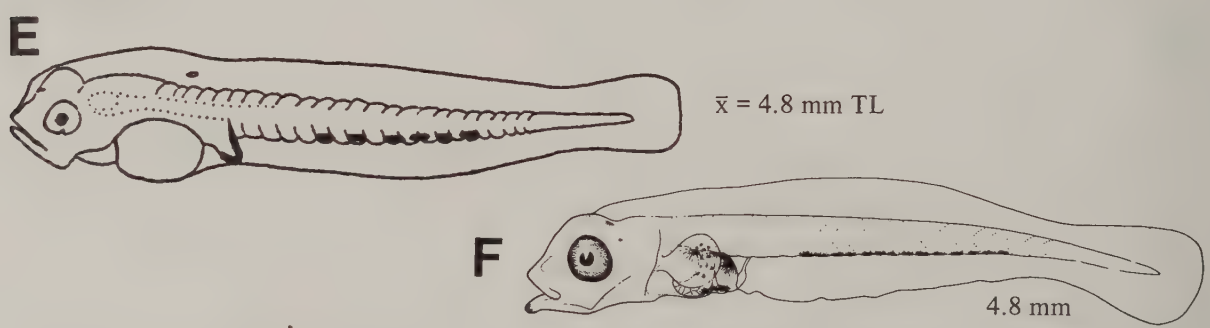
*S. diploproa*




*S. elongatus*




*S. entomelas*

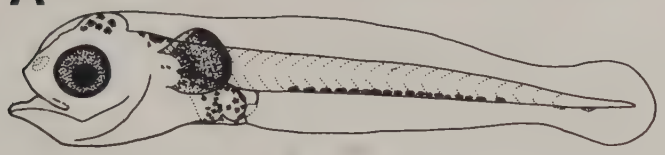



G *S. flavidus*

Figures A, C, Westrheim et al. 1968b; B, G, DeLacy et al. 1964; D, Moser et al. 1977; E, Harling et al. 1971; F, Moser and Butler 1987.

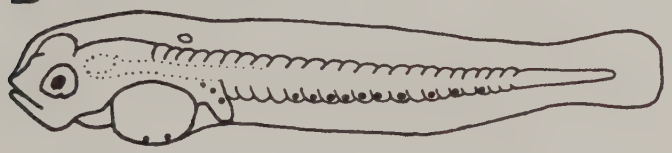
EXTRUSION OR YOLK-EXHAUSTION LARVAE

A *S. goodei*



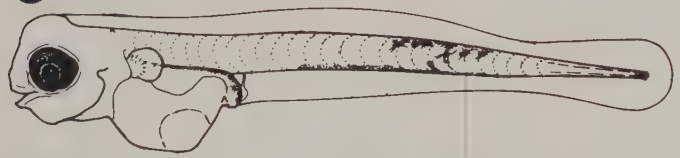
5.8 mm

B *S. helvomaculatus*



$\bar{x}$ = 4.1 mm TL

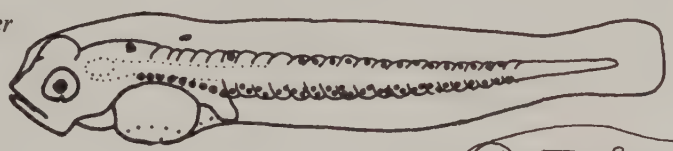
C *S. jordani*



4.6 mm SL

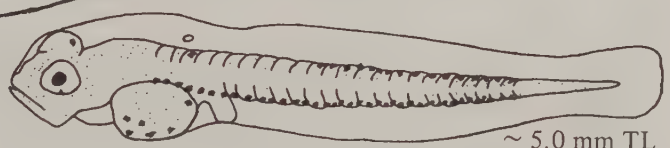
*S. maliger*

D



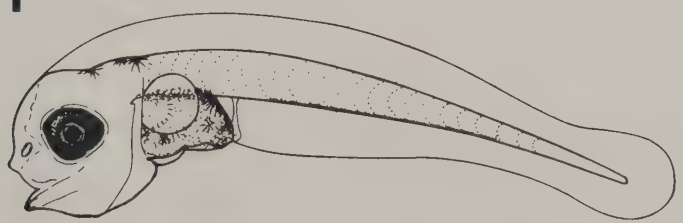
$\bar{x}$ = 5.6 mm TL

E



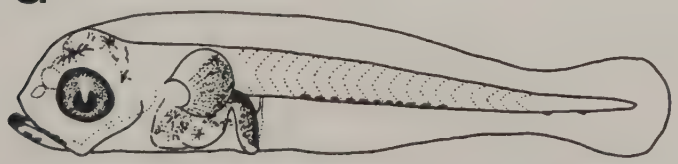
~ 5.0 mm TL

F *S. melanops*



4.0 mm SL

G *S. melanostomus*

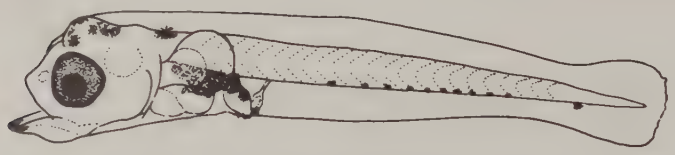


4.4 mm

Figures A, G, Moser et al. 1977; B, D, Westrheim et al. 1968b; C, F, NWAFC originals (B. Vinter); E, DeLacy et al. 1964.

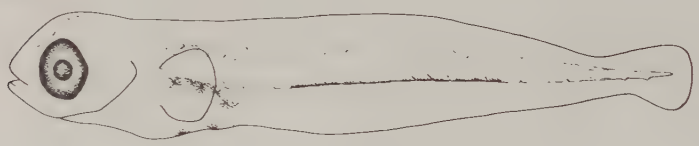
EXTRUSION OR YOLK-EXHAUSTION LARVAE

A *S. miniatus*



4.3 mm

B *S. mystinus*



3.8 mm NL

C *S. paucispinis*

6.1 mm

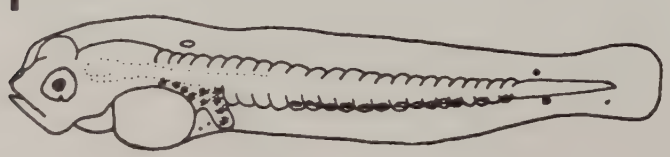
D *S. pinniger*

4.0 mm

E *S. polyspinis*

6.1 mm SL

F *S. proriger*

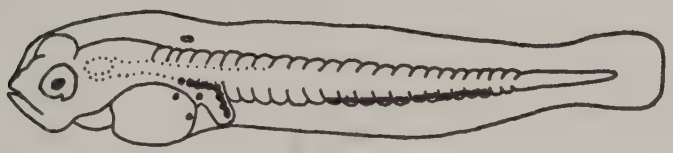


$\bar{x}$ = 5.4 mm TL

Figures A, C–D, Moser et al. 1977; B, Wold, unpubl.; E, NWAFC original (B. Vinter); F, Westrheim et al. 1968b.

EXTRUSION OR YOLK-EXHAUSTION LARVAE

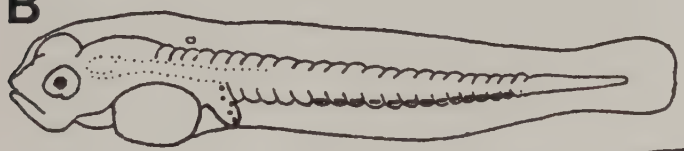
A *S. reedi*



$\bar{x}$ = 6.0 mm TL

*S. ruberrimus*

B

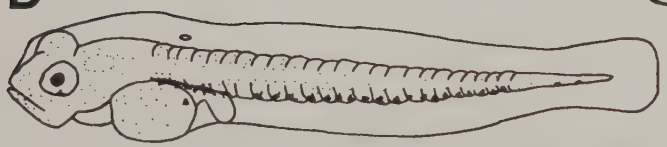


$\bar{x}$ = 4.4 mm TL

C

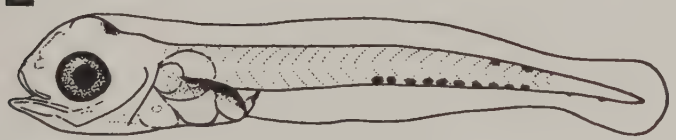
$\bar{x}$ = 4.2 mm TL

D



~ 5.0 mm TL

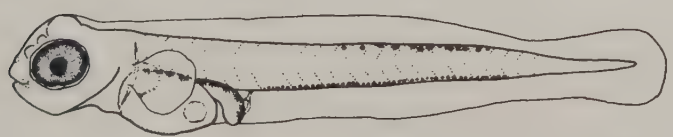
E *S. rufus*



5.3 mm

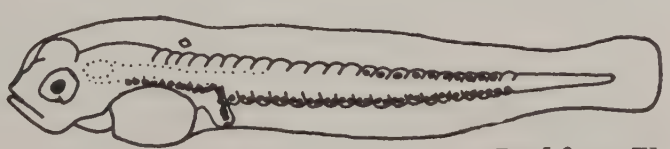
*S. saxicola*

F



4.7 mm

G

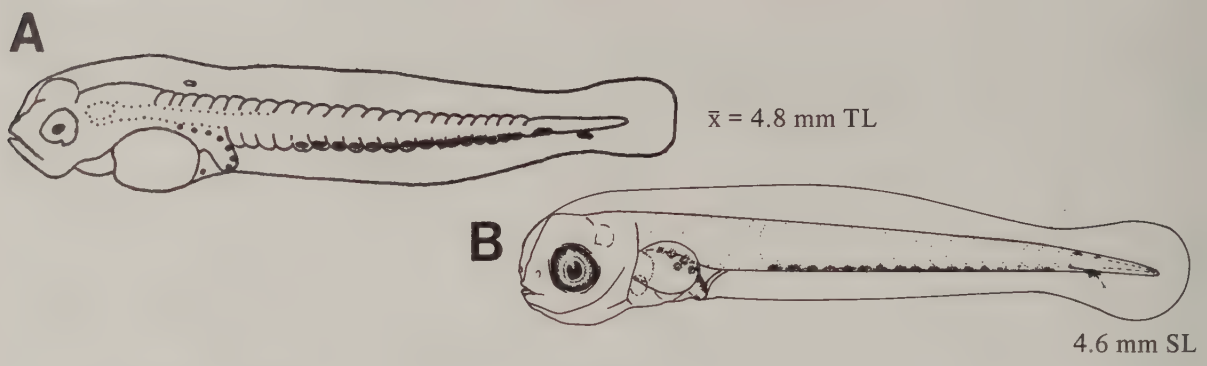


$\bar{x}$ = 5.2 mm TL

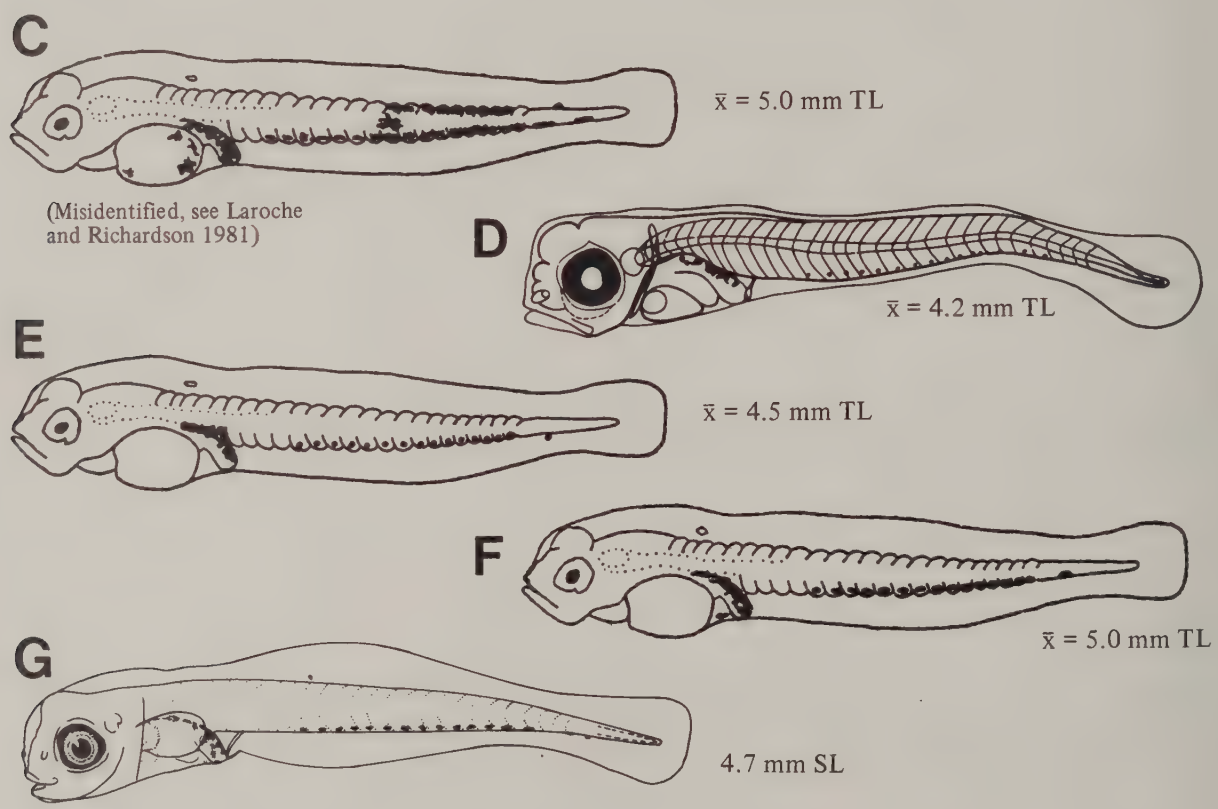
Figures A, G, Westrheim et al. 1968a; B, Harling et al. 1971; C, Westrheim et al. 1968b; D, DeLacy et al. 1964; E–F, Moser et al. 1977.

## EXTRUSION OR YOLK-EXHAUSTION LARVAE

*S. variegatus*




*S. zacentrus*




Figures A, C, F, Harling et al. 1971; B, G, NWAFC originals (B. Vinter); D, Efremenko and Lisovenko 1970; E, Westrheim et al. 1968b.

### *Sebastes* Pelagic Juveniles

The following six pages present illustrations of pelagic juveniles of 33 of the 40 species of *Sebastes* occurring in the study area. Pelagic juveniles of the remaining species are unknown or have not yet been illustrated. Illustrations are grouped to form a pictorial key based primarily on pigment characters of the juveniles as derived from Laroche (in prep.). Species are grouped on the pages according to predominant pigment characters; within these groups, species are separated according to other pigment characters. Several species possess identical states for these characters. Identification of these will require use of additional characters such as meristics, body shape, head spination, time and location of collection, and other pigment characters. These characters should also be checked on fish separated based on the pictorial key to verify their identity. Variation in pigment can be expected due to size and other differences in specimens of a species. Also, pigment characters of species for which pelagic juveniles are unknown may closely resemble those species illustrated here, which would lead to misidentification unless other characters were examined.

PELAGIC JUVENILES
Black pigment blotch at posterior of spinous dorsal fin

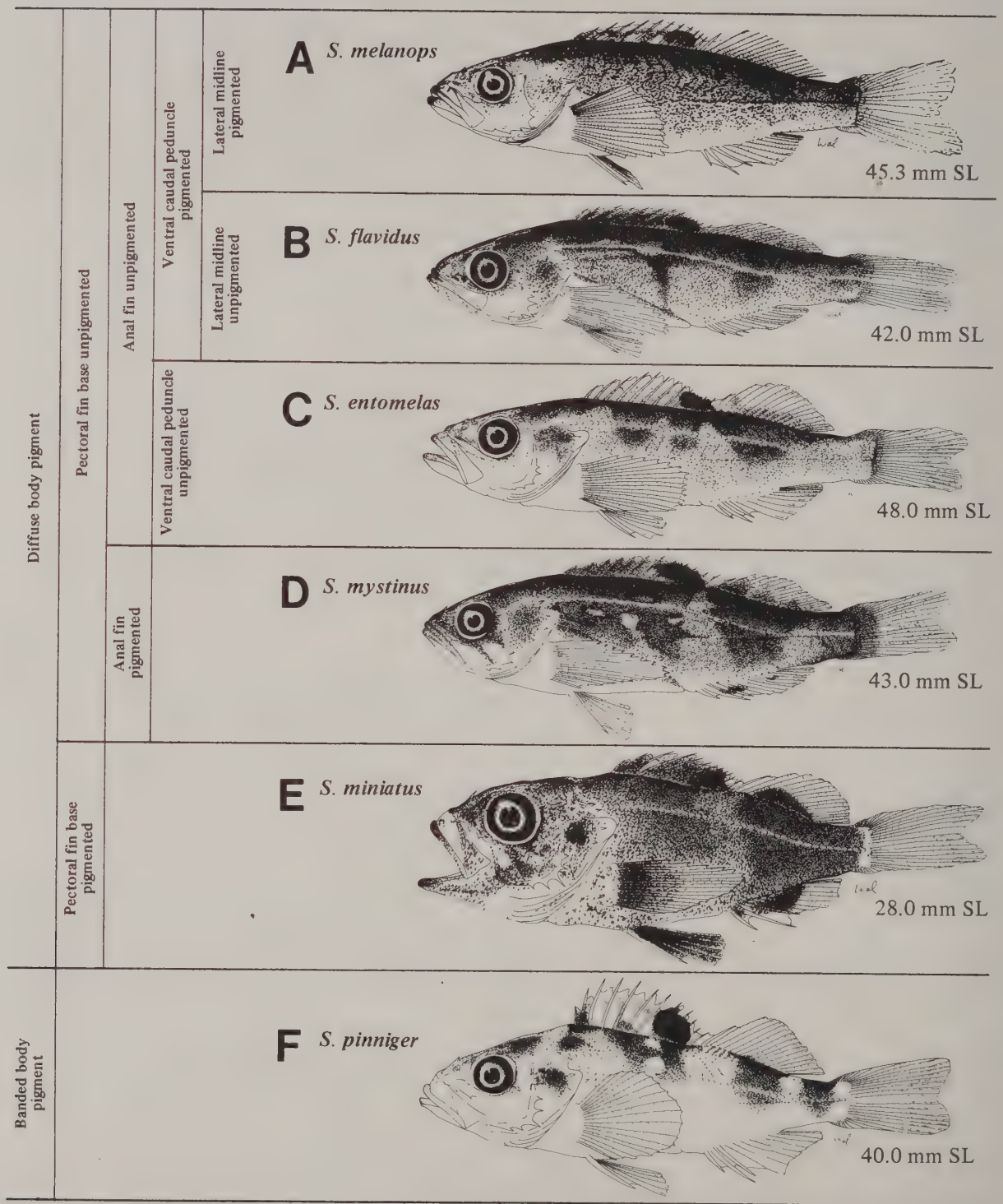



Figure A, Laroche and Richardson 1980; B–F, Laroche, in prep.

PELAGIC JUVENILES
Fringe of pigment on spinous dorsal fin
Body pigment diffuse

Anal fin without distinct stripe of pigment

No fringe of pigment on pectoral and pelvic fins

A *S. alutus*

57.0 mm SL

Fringe of pigment on pectoral and pelvic fins

B *S. paucispinis*

46.0 mm SL

Both soft dorsal and anal fins have distinct stripe of pigment

Caudal fin with distinct band of pigment

C *S. aleutianus*

57.0 mm SL

Caudal fin without distinct band of pigment

D *S. diploproa*

39.0 mm SL

Figures A–D, Laroche, in prep.

## PELAGIC JUVENILES
**Body with three or more distinct bands of pigment**

Saddles or bands extend onto spinous and/or soft dorsal fins

Bands extend onto both spinous and soft dorsal fins

Pectoral fin pigmented proximally

Anal fin pigment uniform

**A** *S. caurinus*

36.0 mm SL

Distinct stripe on anal fin

**B** *S. melanostomus*

46.2 mm SL

Pectoral fin totally pigmented

Pectoral uniformly pigmented

**C** *S. crameri*

39.0 mm SL

Two or more bands of pectoral pigment

**D** *S. nigrocinctus*

53.0 mm SL

Bands extend onto soft dorsal fin only

Fringe of pigment on pectoral

**E** *S. reedi*

49.0 mm SL

Saddles or bands do not extend onto dorsal or anal fins

**F** *S. saxicola*

36.0 mm SL

Bands slant anteroventrally

**G** *S. goodei*

37.0 mm SL

Figures A–G, Laroche, in prep.

## PELAGIC JUVENILES
Diffuse body and dorsal fin pigment
Ventral caudal peduncle pigmented

No distinct pigment along proximal margin of caudal fin

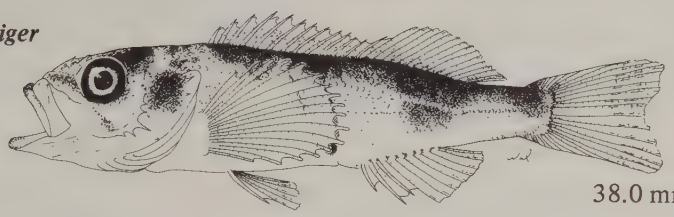
Body pigment aligned along myosepta

**A** *S. auriculatus*

31.0 mm SL

Body pigment not aligned along myosepta

**B** *S. proriger*



38.0 mm SL

**C** *S. zacentrus*

30.0 mm SL

Distinct pigment along proximal margin of caudal fin

Distinct stripe of pigment along proximal margin of soft dorsal and anal fins

**D** *S. rastrelliger*

27.0 mm SL

No distinct stripe of pigment along proximal margin of soft dorsal and anal fins

**E** *S. brevispinis*

41.0 mm SL

Figures A–E, Laroche, in prep.

PELAGIC JUVENILES
Diffuse body and dorsal fin pigment
Ventral caudal peduncle unpigmented

Distinct line of pigment along hypural margin

Bases of anal rays unpigmented

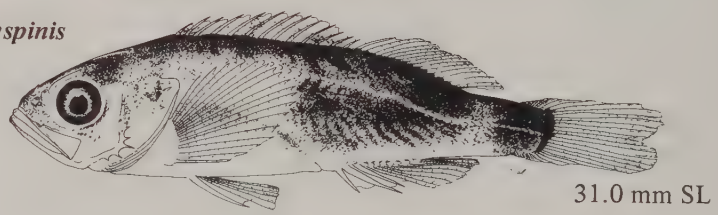
A *S. jordani*

52.0 mm SL

B *S. wilsoni*

35.0 mm SL

Bases of anal rays pigmented



C *S. polyspinis*

31.0 mm SL

No line of pigment along hypural margin

D *S. emphaeus*

30.0 mm SL

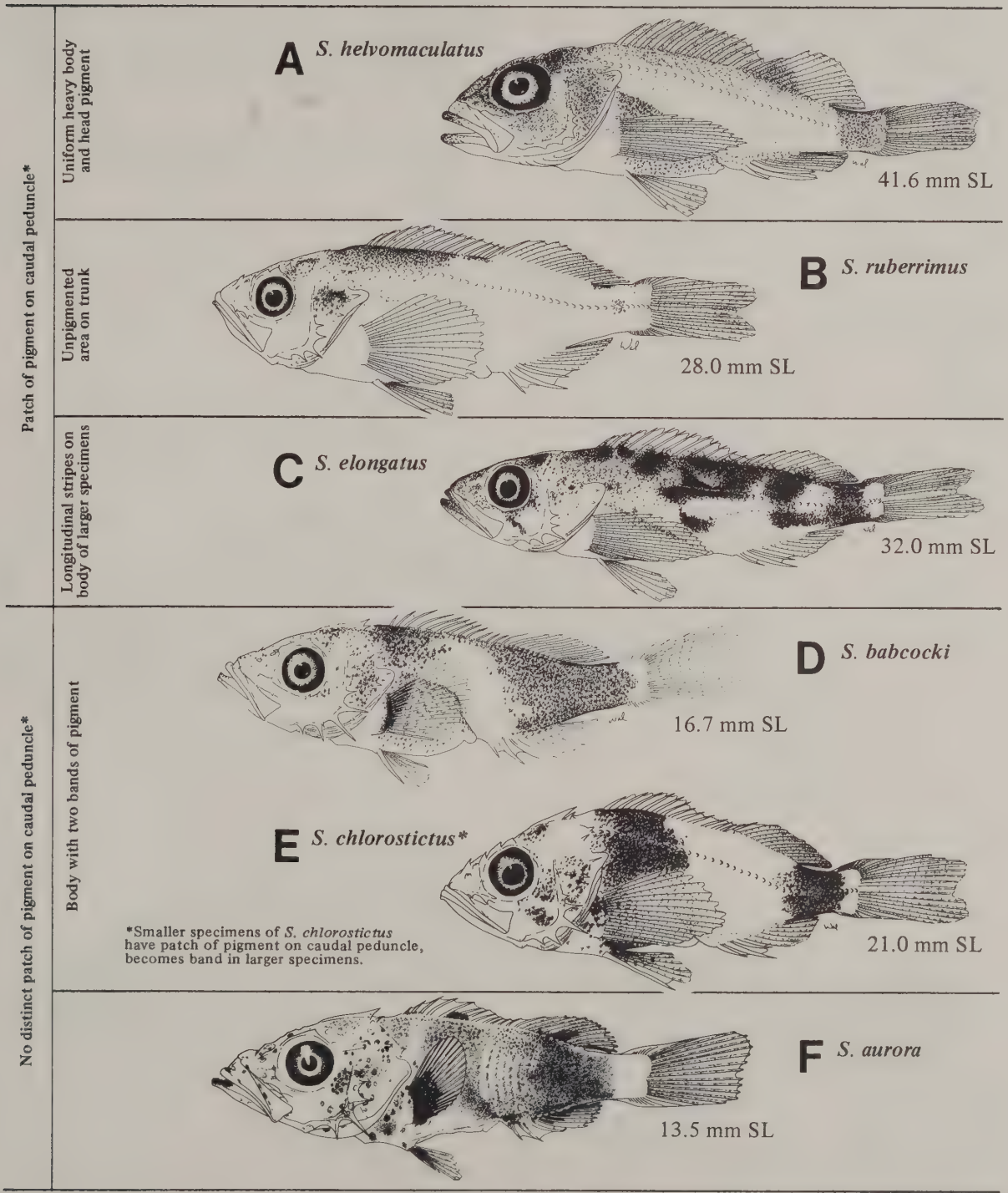
E *S. rufus*

36.0 mm SL

Figures A–D, Laroche, in prep.; E, NWAFC original (B. Vinter).

## PELAGIC JUVENILES

**Body with fewer than three pigment bands, with stripes of pigment, or with a patch of pigment on the caudal peduncle**


Patch of pigment on caudal peduncle*
No distinct patch of pigment on caudal peduncle*
Uniform heavy body and head pigment
Unpigmented area on trunk
Longitudinal stripes on body of larger specimens
Body with two bands of pigment
A S. helvomaculatus
41.6 mm SL
B S. ruberrimus
28.0 mm SL
C S. elongatus
32.0 mm SL
D S. babcocki
16.7 mm SL
E S. chlorostictus*
21.0 mm SL
*Smaller specimens of S. chlorostictus have patch of pigment on caudal peduncle, becomes band in larger specimens.
F S. aurora
13.5 mm SL

Figures A–E, Laroche, in prep.; F, Moser et al. 1985.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 27-27-27 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | X, 8+7, X |
| **Pelvic fin** | Thoracic |
| | S: 1-1-1 R: 5-5-5 |
| **Dorsal fin** | S: 13-13-14 R: 13-14-15 |
| **Pectoral fin** | R: 17-18-19 |
| **Anal fin** | S: 3-3-3 R: 7-7-8 |
| **Gill rakers** | U: 8-9-11 L: 20-22-24 |
| | (T: 28-31-33) |
| **Lateral line pores** | 30-33 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Bering Sea, 54-66°N |
| **Ecology** | Meso- and bathybenthal, 183-732 m |
| **ELH pattern** | Ovoviviparous, pelagic larvae |
| **Spawning** | Season: Apr[a] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## HEAD SPINES

| | |
|---|---|
| **Preocular** | + |
| **Postocular** | + |
| **Coronal** | + |
| **Supraocular** | + |
| **Tympanic** | + |
| **Inferior infraorbital** | 2 |

## EARLY LIFE HISTORY DESCRIPTION

### LARVAE

**Hatch size** 4.1-5.3 mm TL
**Preanal length**
**Length at flexion**
**Length at transformation**
**Sequence of fin development**
**Pigment**

- Extrusion larvae: Series along ventral body
- Postflexion larvae >19.3 mm SL: Pigment covering entire body except on lower cheek, pectoral fin base, and tail tip

**Diagnostic characters**

### PELAGIC JUVENILES

- Body pigment light, diffuse
- Banded pigment on median fins

[a]Hart 1973

Ref: Laroche, in prep.

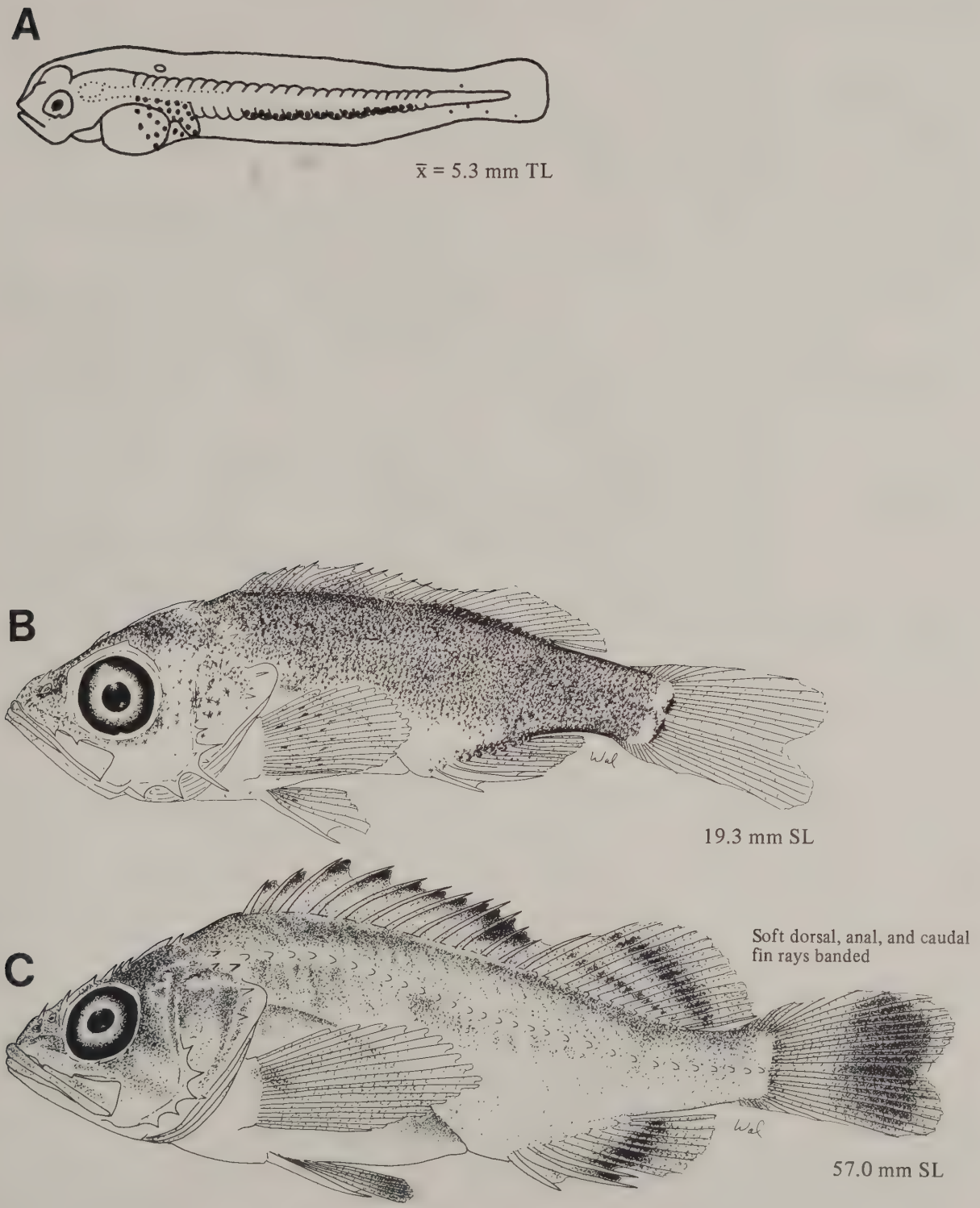



Figure A, Westrheim et al. 1968a; B–C, Laroche, in prep.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 26-26-27 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | 9-11, 8+7, 9-11 |
| **Pelvic fin** | Thoracic |
| | S: 1-1-1 R: 5-5-5 |
| **Dorsal fin** | S: 13-13-13 R: 12-13-14 |
| **Pectoral fin** | R: 16-18-19 |
| **Anal fin** | S: 3-3-3 R: 6-7-7 |
| **Gill rakers** | U: 8-8-10 L: 18-20-21 |
| | (T: 25-27-29) |
| **Lateral line pores** | 42-50 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to SE Alaska, 55-59°N |
| **Ecology** | Nearshore shelf demersal |
| **ELH pattern** | Ovoviviparous, pelagic larvae |
| **Spawning** | Season: Mar-June[a] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: 52,000-339,000[b] |
| **Age at first maturity** | 5 yr (females)[c] |
| **Longevity** | |

## HEAD SPINES

| | |
|---|---|
| **Preocular** | + |
| **Postocular** | + |
| **Coronal** | + |
| **Supraocular** | 0 |
| **Tympanic** | + |
| **Inferior infraorbital** | 2 |

## EARLY LIFE HISTORY DESCRIPTION

### LARVAE

| | |
|---|---|
| **Hatch size** | 4.7-6.7 mm SL |
| **Preanal length** | <50% SL |
| **Length at flexion** | Between 7.4 and 9.0 mm SL |
| **Length at transformation** | |
| **Sequence of fin development** | Caudal and pectorals, pelvics, dorsal and anal |

**Pigment**[d]

- Mostly on dorsal head, with development covering entire head
- Nape
- Gut: Dorsal and ventrolateral surface, increasing laterally with development
- Dorsal and ventral midline melanophores begin posterior to anus; with development, dorsal melanophores extend to nape
- Increase in lateral pigment on posterior half of body and to hypural region
- Pectoral fins

**Diagnostic characters**

Distinguished from *S. caurinus* (p. 296) by

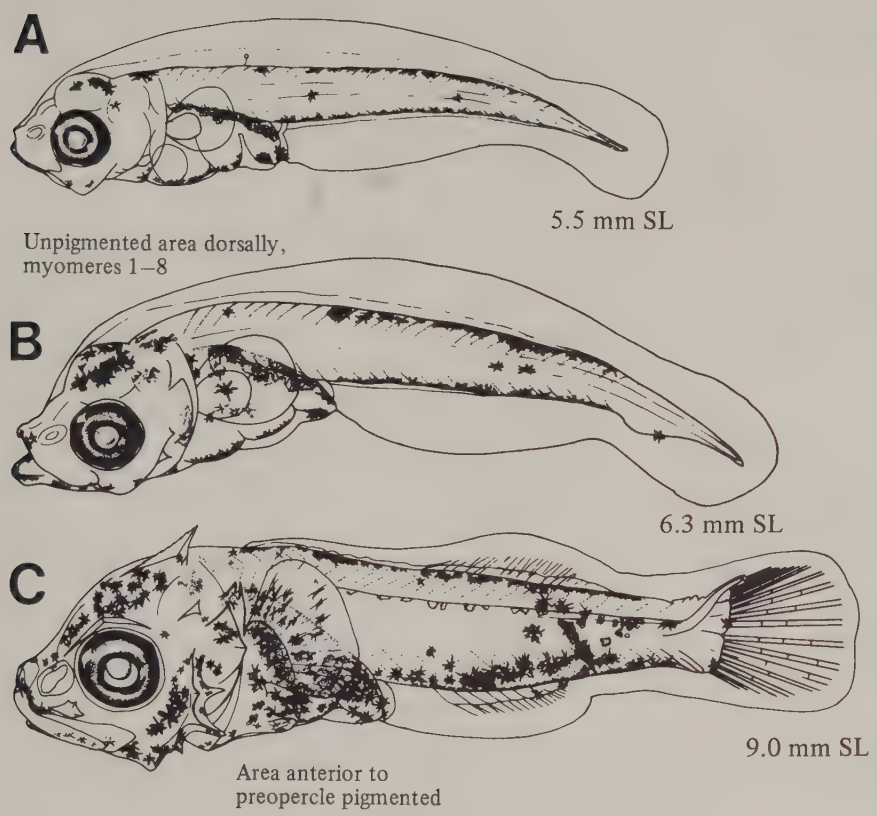
- Dorsal midline melanophores postanally at birth, gradually spread forward to nape
- More pigment on opercular than in *S. caurinus*

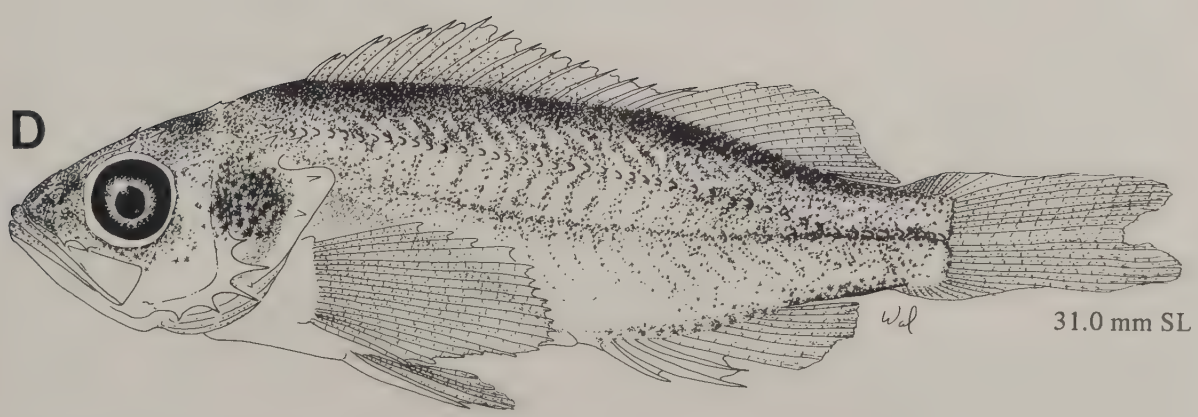
### PELAGIC JUVENILES

- Diffuse body pigment
- Opercular pigment blotch present
- Lateral midline pigmented

[a] Washington et al. 1978
[b] Hart 1973
[c] Wyllie Echeverria 1987
[d] Description of pigment and illustrations based on laboratory-reared specimens which may be more melanistic than wild-caught specimens.

Ref: Laroche, in prep.; Stahl-Johnson (1985), who noted a mistake in Moser et al. (1977); yolk-depleted *S. auriculatus* figure reversed with *S. caurinus*.




Figures A–C, Stahl-Johnson 1985 (reared); D, Laroche, in prep.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 26-26-26 |
| | Precaudal: 10-10-10 |
| | Caudal: 16-16-16 |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | 10, 8+7, 9-10 |
| **Pelvic fin** | Thoracic |
| | S: 1-1-1 R: 5-5-5 |
| **Dorsal fin** | S: 13-13-13 R: 12-13-13 |
| **Pectoral fin** | R: 17-17-19 |
| **Anal fin** | S: 3-3-3 R: 5-6-7 |
| **Gill rakers** | U: 7-8-8 L: 18-19-20 |
| | (T: 24-27-28) |
| **Lateral line pores** | 28-31 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Brit. Col., 48°30′-55°N |
| **Ecology** | Epi-, meso-, and bathybenthal, 125-768 m |
| **ELH pattern** | Ovoviviparous, pelagic larvae |
| **Spawning** | Season: Mar-May (north-central California)[a] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## HEAD SPINES

| | |
|---|---|
| **Preocular**[b] | + |
| **Postocular** | + |
| **Coronal** | 0 |
| **Supraocular** | + |
| **Tympanic** | + |
| **Inferior infraorbital** | 2 |

## EARLY LIFE HISTORY DESCRIPTION

### LARVAE

| | |
|---|---|
| **Hatch size** | 4.4 mm SL |
| **Preanal length** | ~44% increasing with development to 64% SL |
| **Length at flexion** | 6.5-8.6 mm SL |
| **Length at transformation** | 13 mm SL |
| **Sequence of fin development** | Caudal; pectorals; pelvics, dorsal, and anal |

**Pigment**

- Head: Dorsal spots spreading with development to opercle then to entire head
- Snout and jaws pigmented
- Gut: Posterior pigment increasing dorsolaterally with development
- Postanal body: Dorsal and ventral midline over body (between postanal myomeres 4 and 15); lateral pigment increases with development to form a band
- Pectoral fin first, other fins with development

**Diagnostic characters**

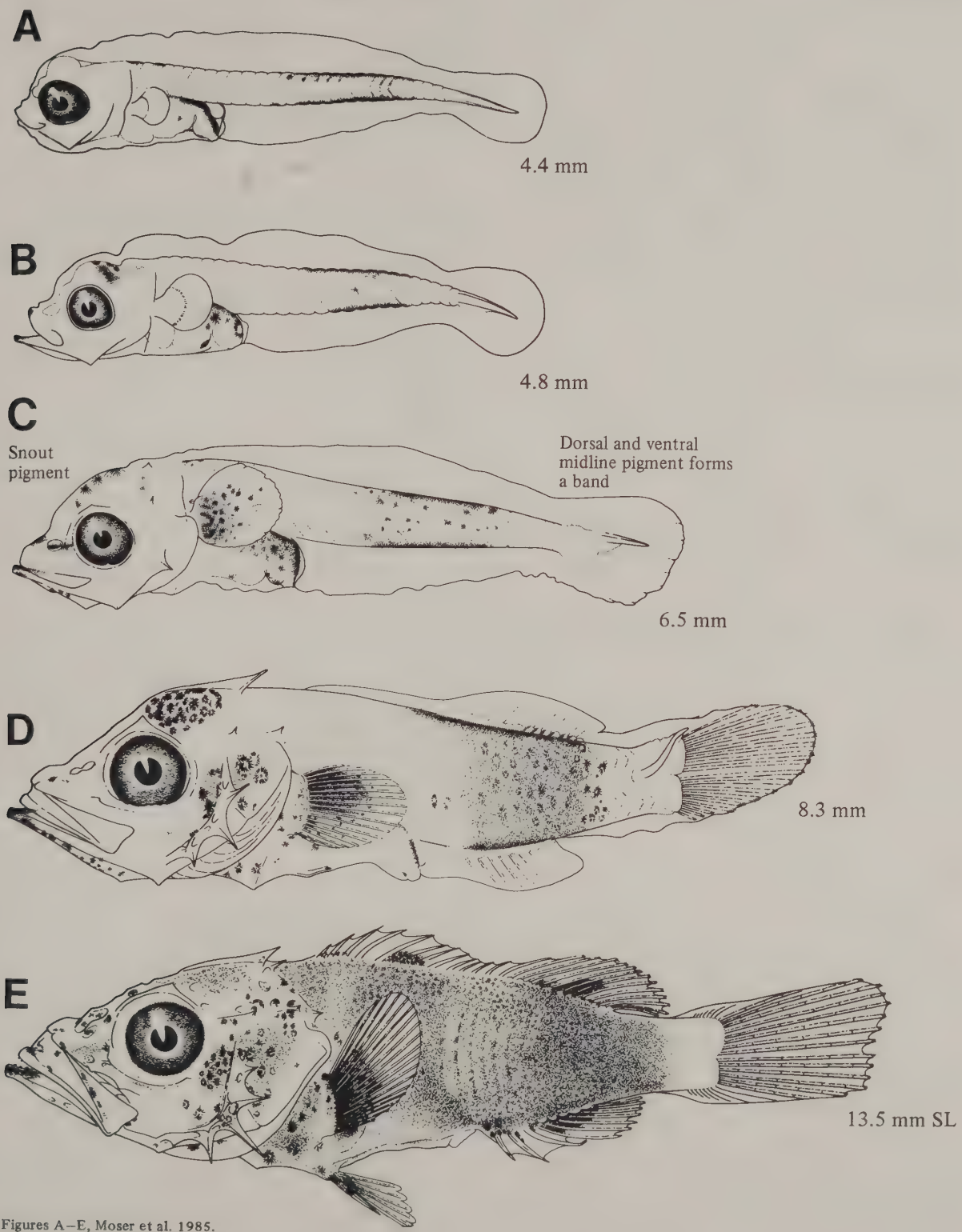
- Morphology: Snout-to-anus length greater than in other species studied
- Pigment: Snout, postanal band

### PELAGIC JUVENILES[c]

- Low total gill raker count (24-28) and lateral line pore count (28-31) are diagnostic for the species
- Body pigment faintly banded with unpigmented caudal peduncle
- Pectoral rays heavily pigmented medially

[a] Wyllie Echeverria 1987
[b] According to Moser et al. (1985), the preocular spine develops by 10.5 mm SL but is not visible on their 13.5-mm SL specimen shown here.
[c] Largest pelagic juvenile collected is 34.4 mm SL.

Ref: Moser et al. 1985.




Figures A–E, Moser et al. 1985.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 26-26-26 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | X, 8+7, X |
| **Pelvic fin** | Thoracic |
| | S: 1-1-1 R: 5-5-5 |
| **Dorsal fin** | S: 13-13-13 R: 13-14-15 |
| **Pectoral fin** | R: 17-19-20 |
| **Anal fin** | S: 3-3-3 R: 6-7-8 |
| **Gill rakers** | U: X-X-X L: X-X-X |
| | (T: 29-31-33) |
| **Lateral line pores** | 42-51 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Bering Sea, 54-66°N |
| **Ecology** | Epi- and mesobenthal, 91-475 mm |
| **ELH pattern** | Ovoviviparous, pelagic larvae |
| **Spawning** | Season: Apr-May[a] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | 4 yr (females)[b] |
| **Longevity** | |

## HEAD SPINES

| | |
|---|---|
| **Preocular** | + |
| **Postocular** | + |
| **Coronal** | 0 |
| **Supraocular** | 0 |
| **Tympanic** | + |
| **Inferior infraorbital** | 2 |

## EARLY LIFE HISTORY DESCRIPTION

### LARVAE

**Hatch size** 4.2-5.3 mm
**Preanal length**
**Length at flexion**
**Length at transformation**
**Sequence of fin development**
**Pigment**

- Extrusion larvae
  - —Series along ventral body
  - —Shorter series along posterior dorsal midline
- Postflexion larvae >14.6 mm SL
  - —Wide postanal band
  - —Light pigment dorsally on head and laterally on gut

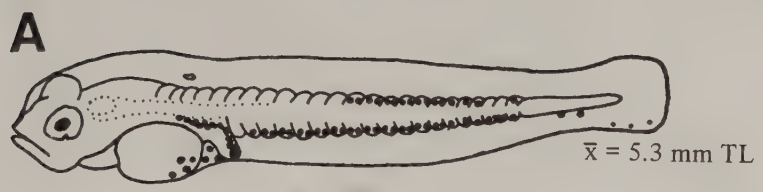
**Diagnostic characters**

### PELAGIC JUVENILES

- Body pigment in two bands
- Little pigment on median fins

[a] Hart 1973
[b] Wyllie Echeverria 1987

Ref: Laroche, in prep.



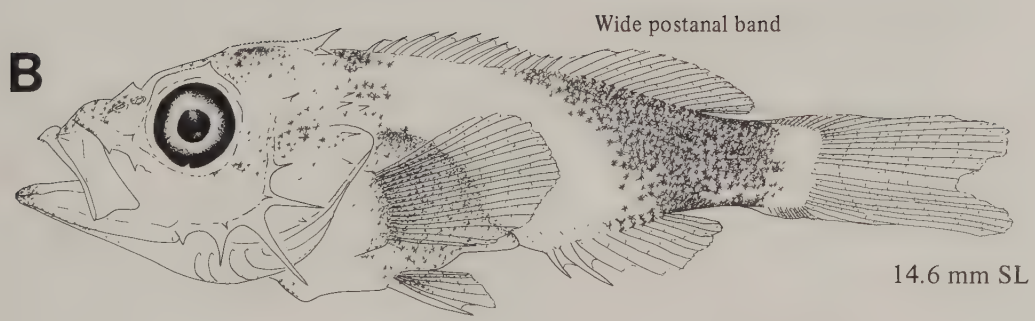



Figure A, Westrheim et al. 1968a; B–C, Laroche, in prep.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 25-26-26<br>Precaudal: X-X-X<br>Caudal: X-X-X |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | 9-11, 8+7, 9-11 |
| **Pelvic fin** | Thoracic<br>S: 1-1-1 R: 5-5-5 |
| **Dorsal fin** | S: 13-13-13 R: 11-13-14 |
| **Pectoral fin** | R: 16-17-18 |
| **Anal fin** | S: 3-3-3 R: 5-6-7 |
| **Gill rakers** | U: 8-X-10 L: 19-X-21<br>(T: 26-28-31) |
| **Lateral line pores** | 39-47 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Gulf of Alaska, 54-60°N |
| **Ecology** | Nearshore shelf demersal, 0-183 m |
| **ELH pattern** | Ovoviviparous, pelagic larvae |
| **Spawning** | Season: Apr[a]<br>Area:<br>Mode:<br>Migration: |
| **Fecundity** | Range/function: 20,000-640,000[a]/ $F=0.000000027404\times L^{4.9567}$, L=TL mm;[b] $F=0.0000000034554\times L^{5.30011}$, L=TL mm[c] |
| **Age at first maturity** | 3-4 yr[d]<br>6 yr (females)[e] |
| **Longevity** | |

## HEAD SPINES

| | |
|---|---|
| **Preocular** | + |
| **Postocular** | + |
| **Coronal** | 0 |
| **Supraocular** | 0 |
| **Tympanic** | + |
| **Inferior infraorbital** | 2 |

## EARLY LIFE HISTORY DESCRIPTION

### LARVAE

| | |
|---|---|
| **Hatch size** | 5.3 mm SL |
| **Preanal length** | 41% SL increasing with development to 49% SL |
| **Length at flexion** | Between 7.5 and 9.5 mm SL |
| **Length at transformation** | |
| **Sequence of fin development** | Caudal and pectorals, pelvics, dorsal and anal |

**Pigment**

- Head: Dorsal and nape spreading, with development, to entire head
- Gut: Dorsal and ventrolateral surface, increasing laterally with development
- Dorsal midline melanophores extend from head to just anterior to tail with no break over gut
- Ventral midline melanophores, with development increasing ventrolaterally and in hypural region

**Diagnostic characters**

- See notes on *S. auriculatus* (p. 290) about reared specimens

Distinguished from *S. auriculatus* by

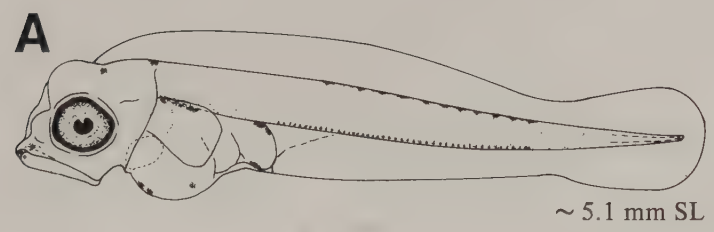
- Until midflexion, more dorsal midline pigment anterior to anus
- Less pigment in the opercular region (flexion and postflexion)

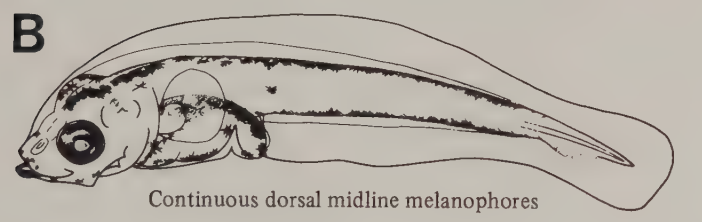
### PELAGIC JUVENILES

- Four pigment bands on body
- Fins pigmented

[a] Hart 1973
[b] Washington et al. 1978
[c] DeLacy et al. 1964
[d] Patten 1973
[e] Wyllie Echeverria 1987

Ref: Laroche, in prep.; Stahl-Johnson 1985.



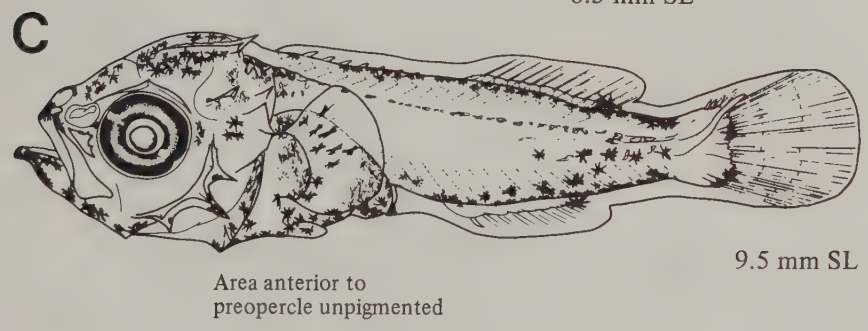



Figure A, NWAFC original (B. Vinter); B–C, Stahl-Johnson 1985 (reared); D, Laroche, in prep.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 26-26-26 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | X, 8+7, X |
| **Pelvic fin** | Thoracic |
| | S: 1-1-1 R: 5-5-5 |
| **Dorsal fin** | S: 13-13-13 R: 13-13-15 |
| **Pectoral fin** | R: 17-18-19 |
| **Anal fin** | S: 3-3-3 R: 7-7-7 |
| **Gill rakers** | U: 8-9-10 L: 21-23-25 |
| | (T: 30-32-34) |
| **Lateral line pores** | 40-51 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Bering Sea, 54-66°N |
| **Ecology** | Epi- and mesobenthal, 29-549 m |
| **ELH pattern** | Ovoviviparous, pelagic larvae |
| **Spawning** | Season: Feb (Brit. Col.[a]-Oregon[b]); Nov-Mar in southern part of range[c] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: 50,000-609,800[c] |
| **Age at first maturity** | 5-6 yr[c] |
| | 4 yr (females)[d] |
| **Longevity** | 30 yr[c] |

## HEAD SPINES

| | |
|---|---|
| **Preocular** | + |
| **Postocular** | + |
| **Coronal** | 0 |
| **Supraocular** | + |
| **Tympanic** | + |
| **Inferior infraorbital** | 2 |

## EARLY LIFE HISTORY DESCRIPTION

### LARVAE

| | |
|---|---|
| **Hatch size** | 5.7 mm SL |
| **Preanal length** | 54-65% SL |
| **Length at flexion** | 8.0-9.3 mm SL |
| **Length at transformation** | 16-21 mm SL[e] |
| **Sequence of fin development** | Caudal and pectorals, pelvics, dorsal and anal |

**Pigment**

- Extrusion larvae: Series along ventral body
- Pigmented pectorals and pelvics
- Heavy nape and top of head
- No dorsal midline
- ~11 ventral midline melanophores reducing to ~4 on caudal peduncle
- Spinous dorsal fin
- Tip of lower jaw

**Diagnostic characters**

- Heavy nape and paired fin pigment
- Pigment on spinous dorsal fin

### PELAGIC JUVENILES

- Five pigment bands on body, four extending onto dorsal fin
- Paired fins heavily pigmented

[a] Hart 1973
[b] Hitz 1962
[c] Phillips 1964
[d] Wyllie Echeverria 1987
[e] Juveniles become benthic at 40-60 mm SL.

Ref: Laroche, in prep.; Richardson and Laroche 1979; Washington et al. 1984b; Westrheim 1975.

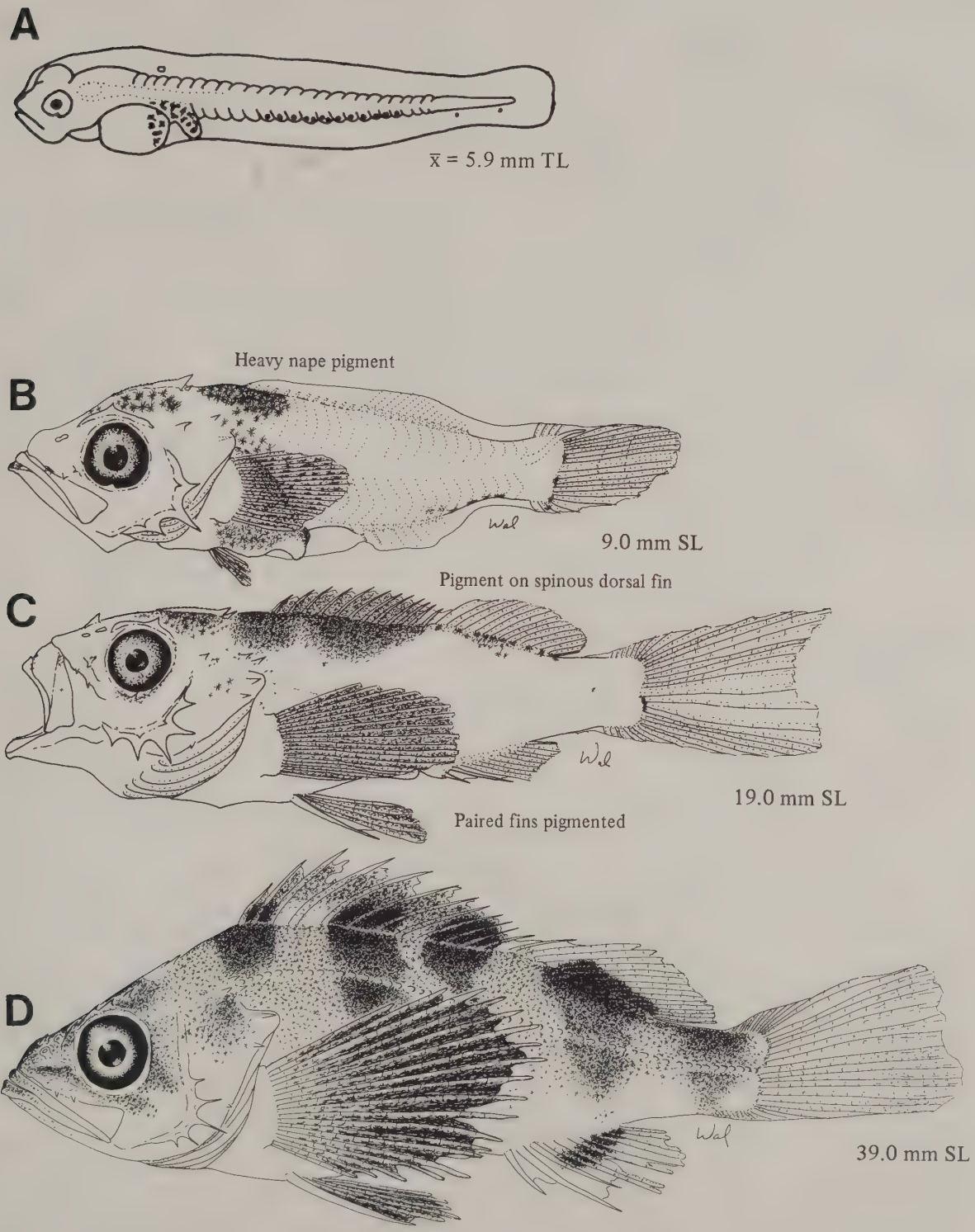



Figure A, Westrheim et al. 1968a; B–C, Richardson and Laroche 1979; D, Laroche, in prep.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 26-26-26 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | X, 8+7, X |
| **Pelvic fin** | Thoracic |
| | S: 1-1-1 R: 5-5-5 |
| **Dorsal fin** | S: 13-13-13 R: 11-12-14 |
| **Pectoral fin** | R: 17-18-18 |
| **Anal fin** | S: 3-3-3 R: 5-7-7 |
| **Gill rakers** | U: 9-10-12 L: 23-24-27 |
| | (T: 32-34-37) |
| **Lateral line pores** | 32-42 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Gulf of Alaska, 54-60°N |
| **Ecology** | Epi- and mesobenthal, 91-579 m |
| **ELH pattern** | Ovoviviparous, pelagic larvae |
| **Spawning** | Season: May-June;[a] July;[b] May-Aug (Oregon)[c] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: 14,000-304,000[d] |
| **Age at first maturity** | 4-5 yr[d] |
| | 7 yr (females)[e] |
| **Longevity** | |

## HEAD SPINES

| | |
|---|---|
| **Preocular** | + |
| **Postocular** | + |
| **Coronal** | 0 |
| **Supraocular** | 0 |
| **Tympanic** | + |
| **Inferior infraorbital** | 2 |

## EARLY LIFE HISTORY DESCRIPTION

### LARVAE

**Hatch size** 5.2 mm
**Preanal length**
**Length at flexion**
**Length at transformation**
**Sequence of fin development**
**Pigment**

- Extrusion larvae: Series along ventral body
- Postflexion larvae >8.7 mm SL
  - —Pigment at base of parietal spine, increasing with development to head and nape
  - —Internal spots along anal fin pterygiophores
  - —Along hypural margin

**Diagnostic characters**

### PELAGIC JUVENILES

- Body and fins (except distal portions) pigmented
- Spinous dorsal fin with fringe of pigment
- Distinct band of pigment on soft dorsal and anal fins

[a] Hart 1973
[b] Westrheim 1975
[c] Hitz 1962
[d] Phillips 1964
[e] Wyllie Echeverria 1987

Ref: Laroche, in prep.

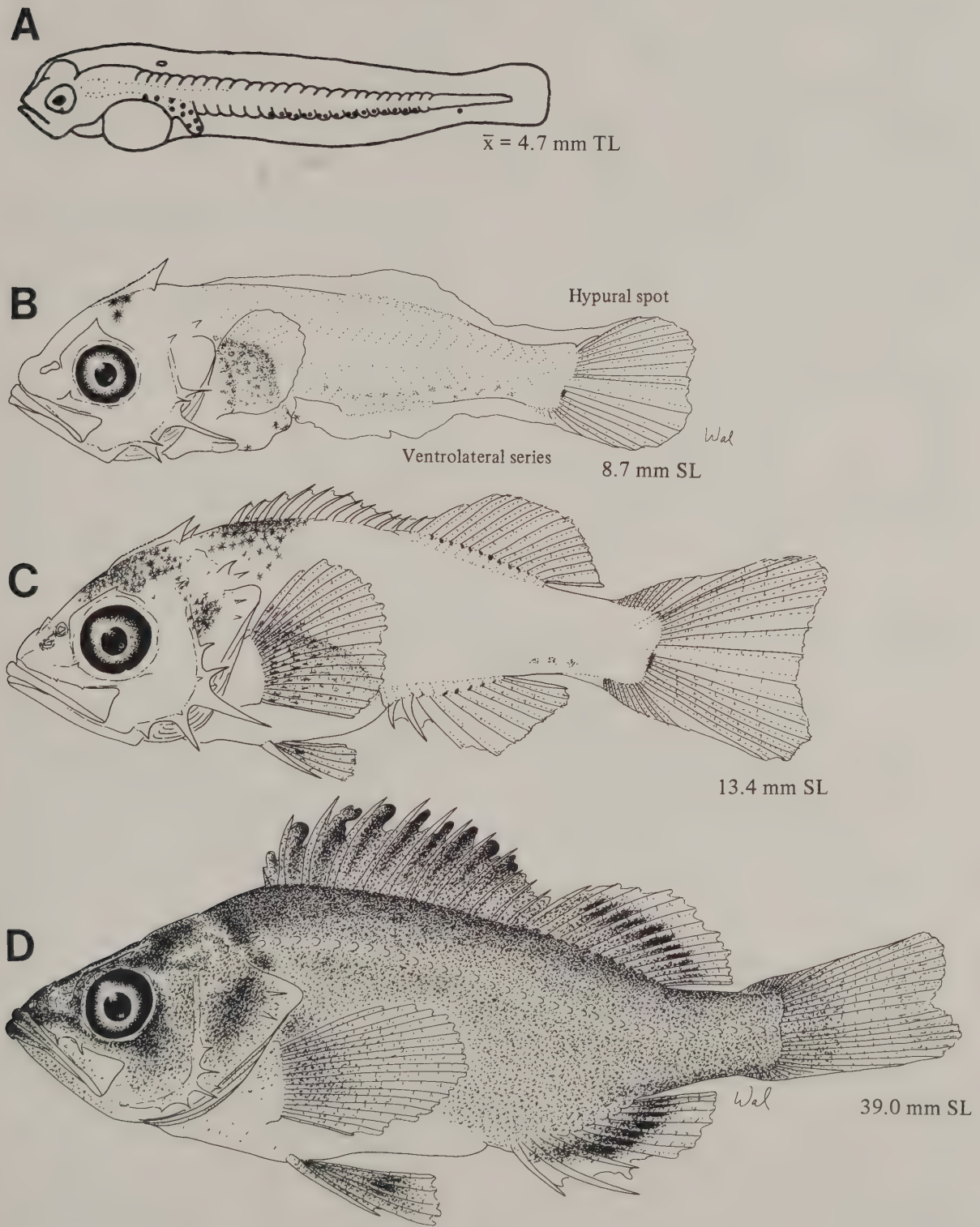



Figure A, Westrheim et al. 1968b; B–D, Laroche, in prep.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 26-26-26 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | X, 8+7, X |
| **Pelvic fin** | Thoracic |
| | S: 1-1-1 R: 5-5-5 |
| **Dorsal fin** | S: 13-13-13 R: 12-13-14 |
| **Pectoral fin** | R: 16-17-18 |
| **Anal fin** | S: 3-3-3 R: 6-6-7 |
| **Gill rakers** | U: 8-9-10 L: 20-22-23 |
| | (T: 29-31-33) |
| **Lateral line pores** | 37-47 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Gulf of Alaska, 54-60°N |
| **Ecology** | Epi- and mesobenthal, 61-402 m |
| **ELH pattern** | Ovoviviparous, pelagic larvae |
| **Spawning** | Season: May-June[a] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | 7 yr (females)[b] |
| **Longevity** | |

## HEAD SPINES

| | |
|---|---|
| **Preocular** | + |
| **Postocular** | + |
| **Coronal** | 0 |
| **Supraocular** | 0 |
| **Tympanic** | + |
| **Inferior infraorbital** | 2 |

## EARLY LIFE HISTORY DESCRIPTION

### LARVAE

**Hatch size** ~5 mm
**Preanal length**
**Length at flexion**
**Length at transformation**
**Sequence of fin development**
**Pigment**

- Extrusion larvae: Series along ventral body
- Postflexion larvae >17.4 mm SL
  - —Along dorsal body margin
  - —Internal row of spots along lateral midline
  - —Above and below notochord along caudal peduncle
  - —A few spots along ventral body margin

**Diagnostic characters**

### PELAGIC JUVENILES

- Body pigment blotchy, longitudinal stripe on larger specimens
- Fins lightly pigmented, or unpigmented

[a] Hart 1973
[b] Wyllie Echeverria 1987

Ref: Laroche, in prep.

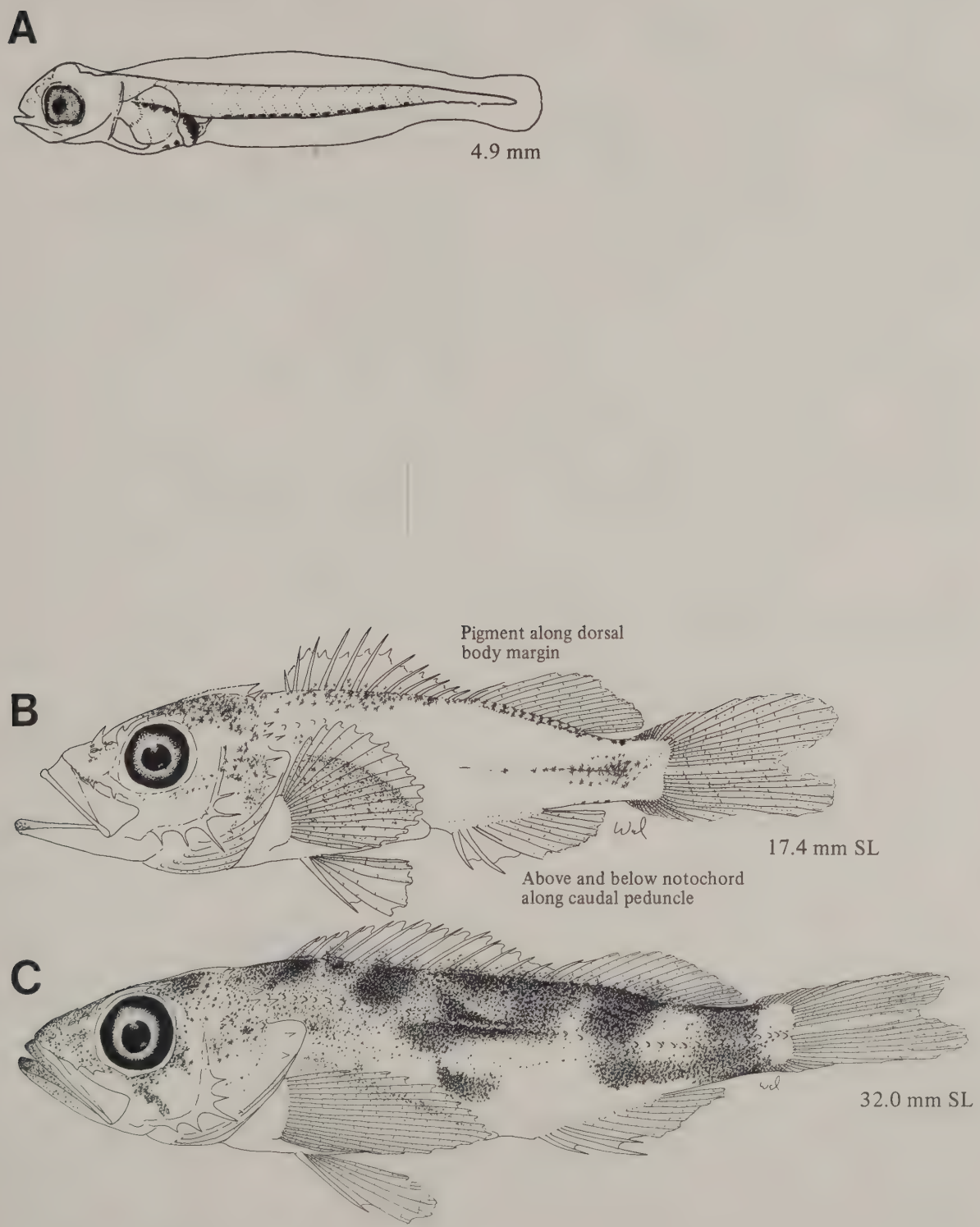



Figure A, Moser et al. 1977; B–C, Laroche, in prep.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 27-27-28 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | X, 8+7, X |
| **Pelvic fin** | Thoracic |
| | S: 1-1-1 R: 5-5-5 |
| **Dorsal fin** | S: 13-13-13 R: 13-14-15 |
| **Pectoral fin** | R: 16-17-18 |
| **Anal fin** | S: 3-3-3 R: 6-7-7 |
| **Gill rakers** | U: 11-11-13 L: 28-30-31 |
| | (T: 37-40-41) |
| **Lateral line pores** | 40-46 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | N. California, 38-42°N, to Gulf of Alaska, 54-60°N |
| **Ecology** | Epi- and mesobenthal, 10-366 m |
| **ELH pattern** | Ovoviviparous, pelagic larvae |
| **Spawning** | Season: Aug-Sept[a] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | 2-3 yr[a] |
| **Longevity** | |

## HEAD SPINES

| | |
|---|---|
| **Preocular** | + |
| **Postocular** | + |
| **Coronal** | 0 |
| **Supraocular** | 0 |
| **Tympanic** | 0 |
| **Inferior infraorbital** | 2 |

## EARLY LIFE HISTORY DESCRIPTION

### LARVAE

**Hatch size**
**Preanal length**
**Length at flexion**
**Length at transformation**
**Sequence of fin development**
**Pigment**

- Postflexion larvae >16.4 mm SL
  - —Along base of soft dorsal fin rays
  - —Along base of parietal spine
  - —Along lateral line in caudal peduncle area

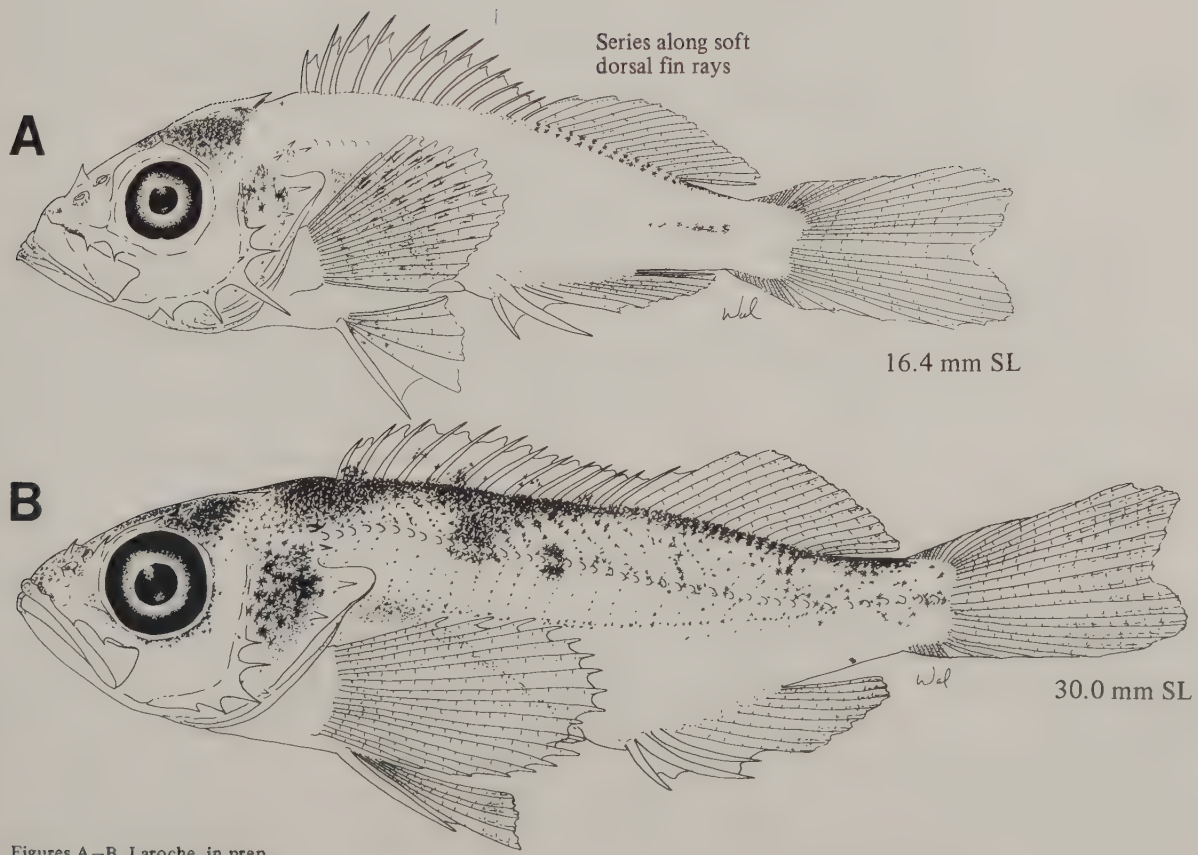
**Diagnostic characters**

### PELAGIC JUVENILES

- Body pigment mainly dorsal to midline
- Opercular blotch present
- Lateral midline pigmented
- Little fin pigment

[a] Moulton 1975

Ref: Laroche, in prep.




Figures A–B, Laroche, in prep.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 26-26-27 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | X, 8+7, X |
| **Pelvic fin** | Thoracic |
| | S: 1-1-1 R: 5-5-5 |
| **Dorsal fin** | S: 13-13-13 R: 14-15-16 |
| **Pectoral fin** | R: 18-18-19 |
| **Anal fin** | S: 3-3-3 R: 7-8-9 |
| **Gill rakers** | U: 9-10-11 L: 24-26-28 |
| | (T: 34-36-38) |
| **Lateral line pores** | 54-60 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Gulf of Alaska, 54-60°N |
| **Ecology** | Epi- and mesobenthal, 0-375 m |
| **ELH pattern** | Ovoviviparous, pelagic larvae |
| **Spawning** | Season: Nov-Mar;[a] |
| | Apr (British Columbia)[b] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: 55,600-915,200[a] |
| **Age at first maturity** | 3-4 yr (California)[a] |
| | 5 yr (females)[c] |
| **Longevity** | 28 yr[d] |
| | 56 yr (females)[e] |
| | 57 yr (males)[e] |

## HEAD SPINES

| | |
|---|---|
| **Preocular** | + |
| **Postocular** | + |
| **Coronal** | 0 |
| **Supraocular** | + |
| **Tympanic** | + |
| **Inferior infraorbital** | 3 |

## EARLY LIFE HISTORY DESCRIPTION

### LARVAE

| | |
|---|---|
| **Hatch size** | 4.5-5.0 mm SL (pre-extrusion) |
| **Preanal length** | 56-61% SL |
| **Length at flexion** | 9.9-12.9 mm SL, complete at 14 mm SL |
| **Length at transformation** | 21.7-30.6 mm SL[f] |
| **Sequence of fin development** | Caudal and pectorals, pelvics, dorsal and anal |

**Pigment**

- Extrusion larvae: Short series midway along ventral body
- Larvae >10 mm SL
  - —Beneath dorsal fin
  - —Above and below notochord at tail
  - —Dorsal and ventral margin of caudal peduncle
  - —Moderate on paired fins

**Diagnostic characters**

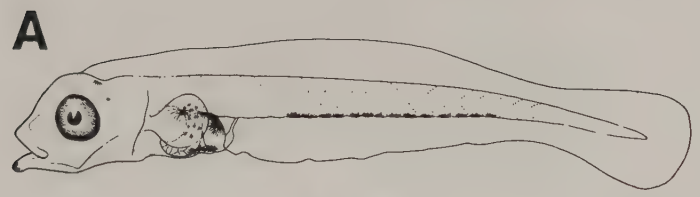
- Pigment along dorsal fin base
- Relatively slender body
- No pigment at anal ray bases
- Pigment at tip of notochord

### PELAGIC JUVENILES

- Pigment blotch on last few dorsal fin spines
- Body heavily pigmented
- Pectoral fin base, anal fin, and ventral caudal peduncle unpigmented

[a] Phillips 1964
[b] Westrheim 1975
[c] Wyllie Echeverria 1987
[d] Toole 1982
[e] R. Mandapat, Wash. Dep. Fish., 7600 Sand Point Way N.E., Seattle, WA 98115-0070, pers. commun., 1 June 1987.
[f] Juveniles are pelagic at 55-75 mm SL.

Ref: Laroche, in prep.; Laroche and Richardson 1981; Moser and Butler 1987; Washington et al. 1984b.



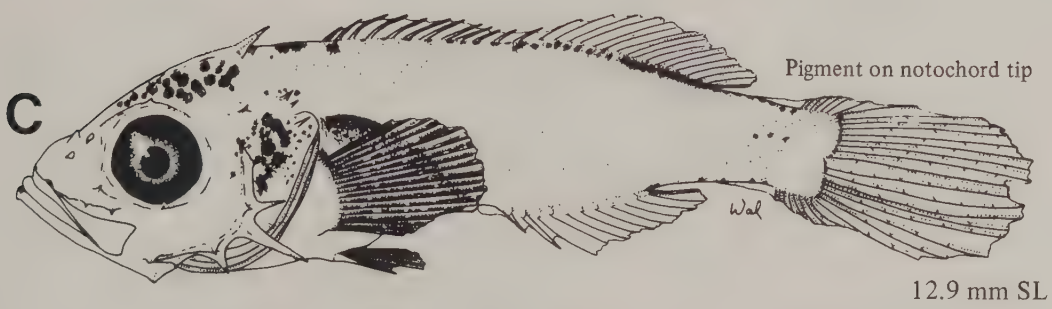


Figure A, Moser and Butler 1987; B–C, Laroche and Richardson 1981; D, Laroche, in prep.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 26-26-26 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | 12, 8+7, 12-13 |
| **Pelvic fin** | Thoracic |
| | S: 1-1-1 R: 5-5-5 |
| **Dorsal fin** | S: 12-13-13 R: 14-14-15 |
| **Pectoral fin** | R: 17-18-18 |
| **Anal fin** | S: 3-3-3 R: 7-8-8 |
| **Gill rakers** | U: 8-11-12 L: 24-26-27 (T: 34-36-37) |
| **Lateral line pores** | 49-55 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Gulf of Alaska, 54-60°N |
| **Ecology** | Epi- and mesobenthal, 0-549 m |
| **ELH pattern** | Ovoviviparous, pelagic larvae |
| **Spawning** | Season: Nov-Feb;[a] Mar[b] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: 48,000-632,800/ F=82721.8×L−323516[c] |
| **Age at first maturity** | 3-5 yr[a] |
| | 7 yr (females)[d] |
| **Longevity** | |

## HEAD SPINES

| | |
|---|---|
| **Preocular** | 0 |
| **Postocular** | + |
| **Coronal** | 0 |
| **Supraocular** | 0 |
| **Tympanic** | + |
| **Inferior infraorbital** | 3 |

## EARLY LIFE HISTORY DESCRIPTION

### LARVAE

| | |
|---|---|
| **Hatch size** | 4.5 mm SL (pre-extrusion) |
| **Preanal length** | 50-75% SL |
| **Length at flexion** | Complete at 10.1 mm SL |
| **Length at transformation** | 23-27 mm SL[e] |
| **Sequence of fin development** | Caudal and pectorals, pelvics, dorsal and anal |

**Pigment**

- Extrusion larvae: Series along ventral body
- See also *S. melanops* (p. 314)
- Moderate on paired fins
- Over tip of notochord
- Along base of second dorsal fin, developing all along dorsal midline
- Dorsal and ventral margin of caudal peduncle
- At bases of some dorsal and anal fin rays

**Diagnostic characters**

- See also *S. melanops*
- Number of pectoral fin rays (18)
- Lateral line pores 49-55, usually >50
- Slender caudal peduncle
- Heavy pigment develops along entire dorsal midline
- Pigment at bases of some dorsal and anal fin rays

### PELAGIC JUVENILES

- Pigment blotch on last few dorsal fin spines
- Body heavily pigmented, diffuse
- Ventral caudal peduncle pigmented

[a] Phillips 1964
[b] Westrheim 1975
[c] Gunderson et al. 1980
[d] Wyllie Echeverria 1987
[e] Juveniles are pelagic at 40-50 mm SL.

Ref: DeLacy et al. 1964; Laroche, in prep.; Laroche and Richardson 1980.

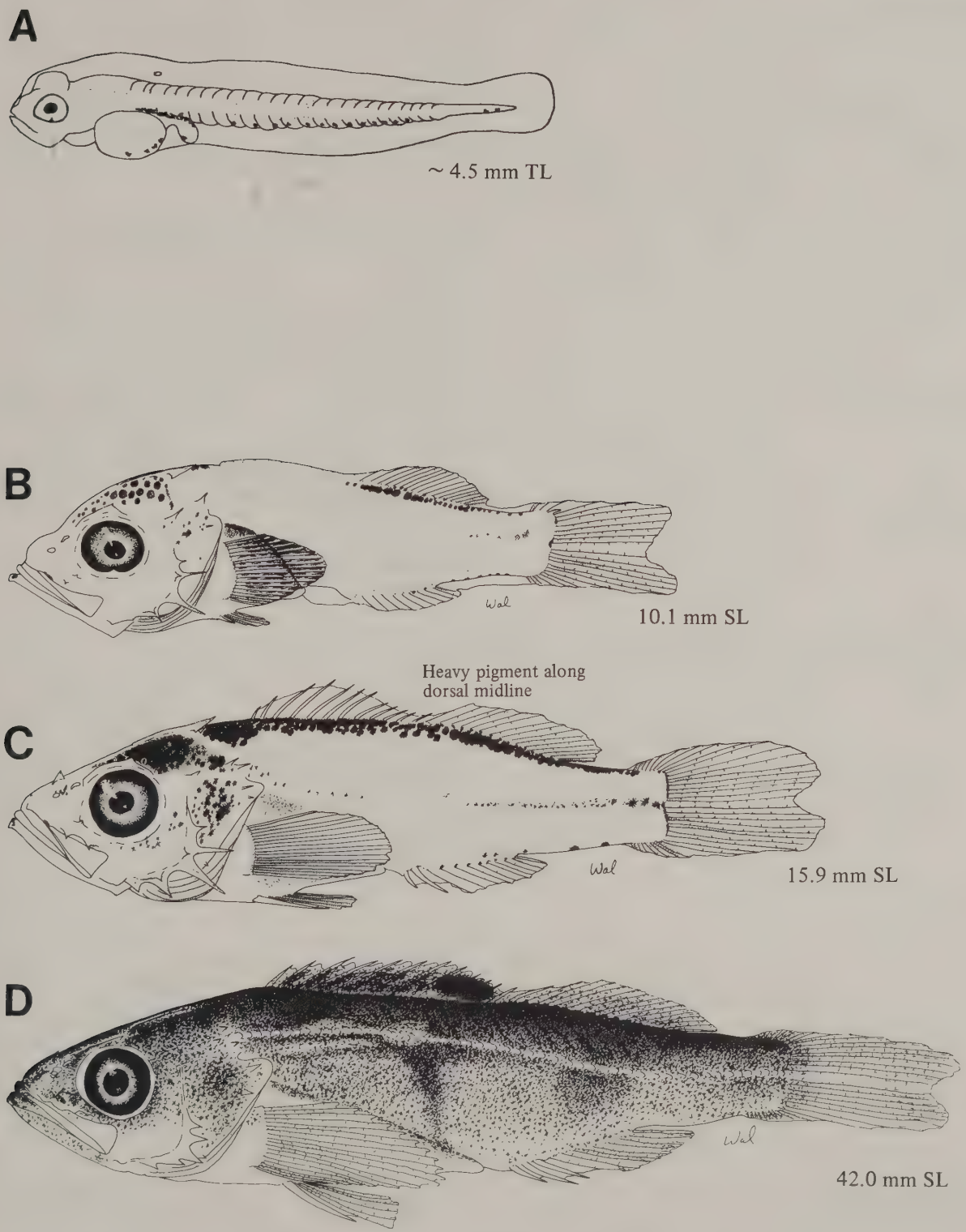



Figure A, DeLacy et al. 1964; B–C, Laroche and Richardson 1980; D, Laroche, in prep.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 26-26-26 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | X, 8+7, X |
| **Pelvic fin** | Thoracic |
| | S: 1-1-1 R: 3-5-5 |
| **Dorsal fin** | S: 12-13-14 R: 12-13-14 |
| **Pectoral fin** | R: 15-16-17 |
| **Anal fin** | S: 3-3-3 R: 6-6-7 |
| **Gill rakers** | U: 8-9-9 L: 19-21-22 |
| | (T: 28-30-33) |
| **Lateral line pores** | 34-45 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Gulf of Alaska, 54-60°N |
| **Ecology** | Epi- and mesobenthal, 25-549 m |
| **ELH pattern** | Ovoviviparous, pelagic larvae |
| **Spawning** | Season: June[a] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | 8 yr (females)[b] |
| **Longevity** | |

## HEAD SPINES

| | |
|---|---|
| **Preocular** | + |
| **Postocular** | + |
| **Coronal** | 0 |
| **Supraocular** | + |
| **Tympanic** | + |
| **Inferior infraorbital** | 2 |

## EARLY LIFE HISTORY DESCRIPTION

### LARVAE

| | |
|---|---|
| **Hatch size** | 4.1 mm SL |
| **Preanal length** | 56-63% SL |
| **Length at flexion** | 7.7-8.8 mm SL |
| **Length at transformation** | 12.0-18.6 mm SL[c] |
| **Sequence of fin development** | Caudal and pectorals, pelvics, dorsal and anal |

**Pigment**

- Extrusion larvae: Series along ventral body
- Lack of body pigment, with development caudal peduncle patch
- Pigmented area at base of long parietal spine
- Pigmented fringes of pectoral and pelvic fins

**Diagnostic characters**

- Pigmented fringes of pectoral and pelvic fins
- Lack of body pigment
- Long serrate parietal and middle posterior preopercular spines

### PELAGIC JUVENILES

- Body pigment diffuse, heavier over gut and on caudal peduncle

[a] Westrheim 1975
[b] Wyllie Echeverria 1987
[c] Juveniles are pelagic to 60 mm SL.

Ref: Laroche, in prep.; Richardson and Laroche 1979; Washington et al. 1984b; Westrheim 1975.

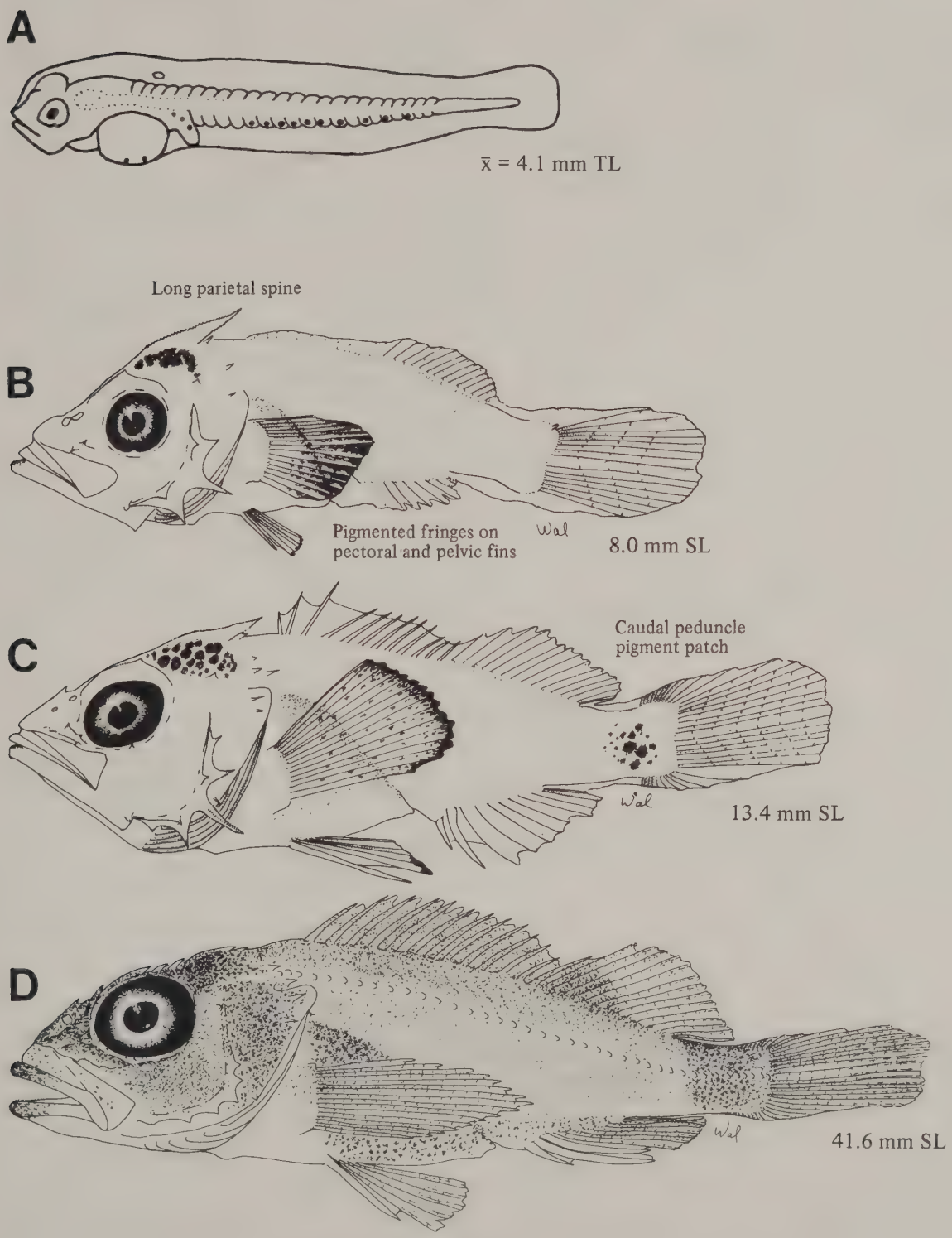



Figure A, Westrheim et al. 1968a; B–C, Richardson and Laroche 1979; D, Laroche, in prep.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 26-26-26 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | X, 8+7, X |
| **Pelvic fin** | Thoracic |
| | S: 1-1-1 R: 5-5-5 |
| **Dorsal fin** | S: 13-13-13 R: 13-14-16 |
| **Pectoral fin** | R: 19-20-22 |
| **Anal fin** | S: 3-3-3 R: 9-9-10 |
| **Gill rakers** | U: 12-12-12 L: 31-31-31 |
| | (T: 40-44-47) |
| **Lateral line pores** | 53-64 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Gulf of Alaska, 54-60°N |
| **Ecology** | Epi- and mesobenthal, 0-350 m |
| **ELH pattern** | Ovoviviparous, pelagic larvae |
| **Spawning** | Season: Nov-Mar;[a] Mar[b] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: 7000-50,000[c] |
| **Age at first maturity** | 3 yr (females)[d] |
| **Longevity** | |

## HEAD SPINES

| | |
|---|---|
| **Preocular** | + |
| **Postocular** | + |
| **Coronal** | 0 |
| **Supraocular** | 0 |
| **Tympanic** | + |
| **Inferior infraorbital** | 2 |

## EARLY LIFE HISTORY DESCRIPTION

### LARVAE

| | |
|---|---|
| **Hatch size** | 5.4 mm SL |
| **Preanal length** | 36%, with development 54% SL |
| **Length at flexion** | 8-10 mm SL |
| **Length at transformation** | ~27-30 mm SL[e] |
| **Sequence of fin development** | Caudal and pectorals, pelvics, dorsal and anal |

**Pigment**

- Brain (dorsal head on crown)
- Pigment over dorsolateral surface of gut
- Dorsal and ventral postanal midline (see illustrations)

**Diagnostic characters**

- Most slender *Sebastes* sp. larvae described to date (body depth <25% SL)
- Large larvae (5.4 mm SL at hatching, 8-10 mm SL at flexion)
- Opposing dorsal and ventral postanal midline pigment
- Anterior placement of anus in juveniles/adults
- Large gap between anus and origin of anal fin

### PELAGIC JUVENILES

- Elongate shape, large gap between anus and origin of anal fin
- Body pigment diffuse, but myosepta pattern evident

[a] Phillips 1964
[b] Westrheim 1975
[c] Hart 1973
[d] Wyllie Echeverria 1987
[e] Juveniles are pelagic at 30-63 mm SL.

Ref: Laroche, in prep.; Moser et al. 1977; Washington et al. 1984b.

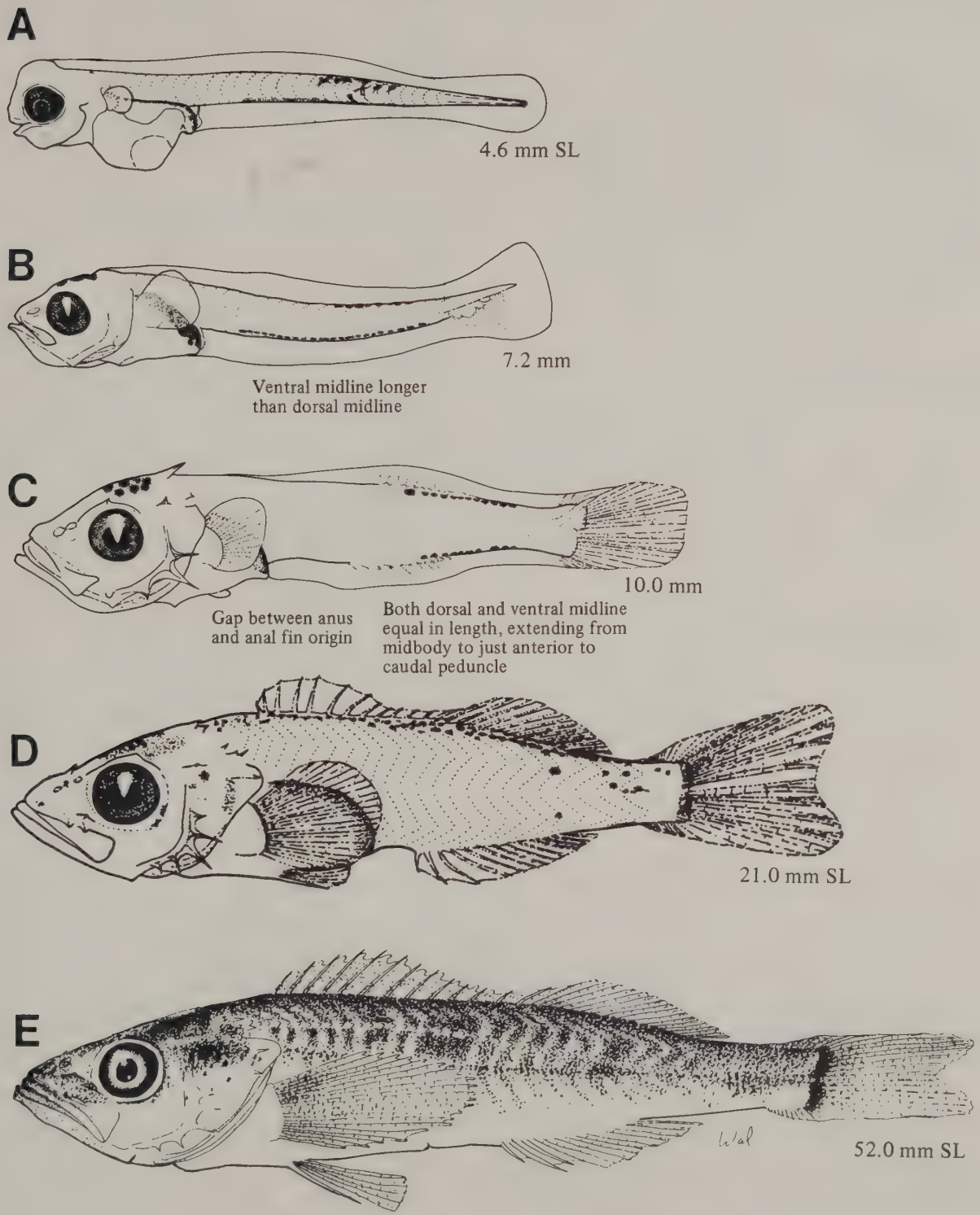



Figure A, NWAFC original (B. Vinter); B–D, Moser et al. 1977; E, Laroche, in prep.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 26-26-26 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | 12, 8+7, 12-13 |
| **Pelvic fin** | Thoracic |
| | S: 1-1-1 R: 5-5-5 |
| **Dorsal fin** | S: 13-13-14 R: 14-15-15 |
| **Pectoral fin** | R: 18-19-19 |
| **Anal fin** | S: 3-3-3 R: 7-8-9 |
| **Gill rakers** | U: 9-11-13 L: 23-26-28 |
| | (T: 34-37-38) |
| **Lateral line pores** | 47-55 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Cent. California, 34-38°N, to Aleutian Is., 51-55°N |
| **Ecology** | Epi- and mesobenthal, 0-366 m |
| **ELH pattern** | Ovoviviparous, pelagic larvae |
| **Spawning** | Season: Jan;[a] Feb-Apr[b] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | 7 yr (females)[c] |
| **Longevity** | |

## HEAD SPINES

| | |
|---|---|
| **Preocular** | 0 |
| **Postocular** | + |
| **Coronal** | 0 |
| **Supraocular** | 0 |
| **Tympanic** | + |
| **Inferior infraorbital** | 3 |

## EARLY LIFE HISTORY DESCRIPTION

### LARVAE

| | |
|---|---|
| **Hatch size** | |
| **Preanal length** | 50-75% SL |
| **Length at flexion** | Complete at 10.6 mm SL |
| **Length at transformation** | 24-33 mm SL[d] |
| **Sequence of fin development** | Caudal and pectorals, pelvics, dorsal and anal |

**Pigment**

- Extrusion larvae: Series along ventral body
- Larvae >10.6 mm SL
  - —Head, on crown and opercle
  - —Pigment over dorsolateral surface of gut
  - —Dorsal midline heavier than ventral midline
  - —Hypural margin
  - —Along posterior lateral line, extends anteriorly along notochord with development
  - —Paired fin blades moderately pigmented
  - —Discrete melanophores at the articulation of several dorsal and anal fin rays

**Diagnostic characters**

Distinguished from *S. flavidus* (p. 308) by

- High pectoral fin ray count (usually 19)
- Fewer lateral line pores (usually <50)
- Deeper, shorter caudal peduncle

### PELAGIC JUVENILES

- Body pigment heavy, diffuse
- Pigment blotch on last few dorsal fin spines
- Lateral midline pigmented

[a] Westrheim 1975
[b] Hart 1973
[c] Wyllie Echeverria 1987
[d] Juveniles are pelagic at 40-50 mm SL.

Ref: Laroche and Richardson 1980.

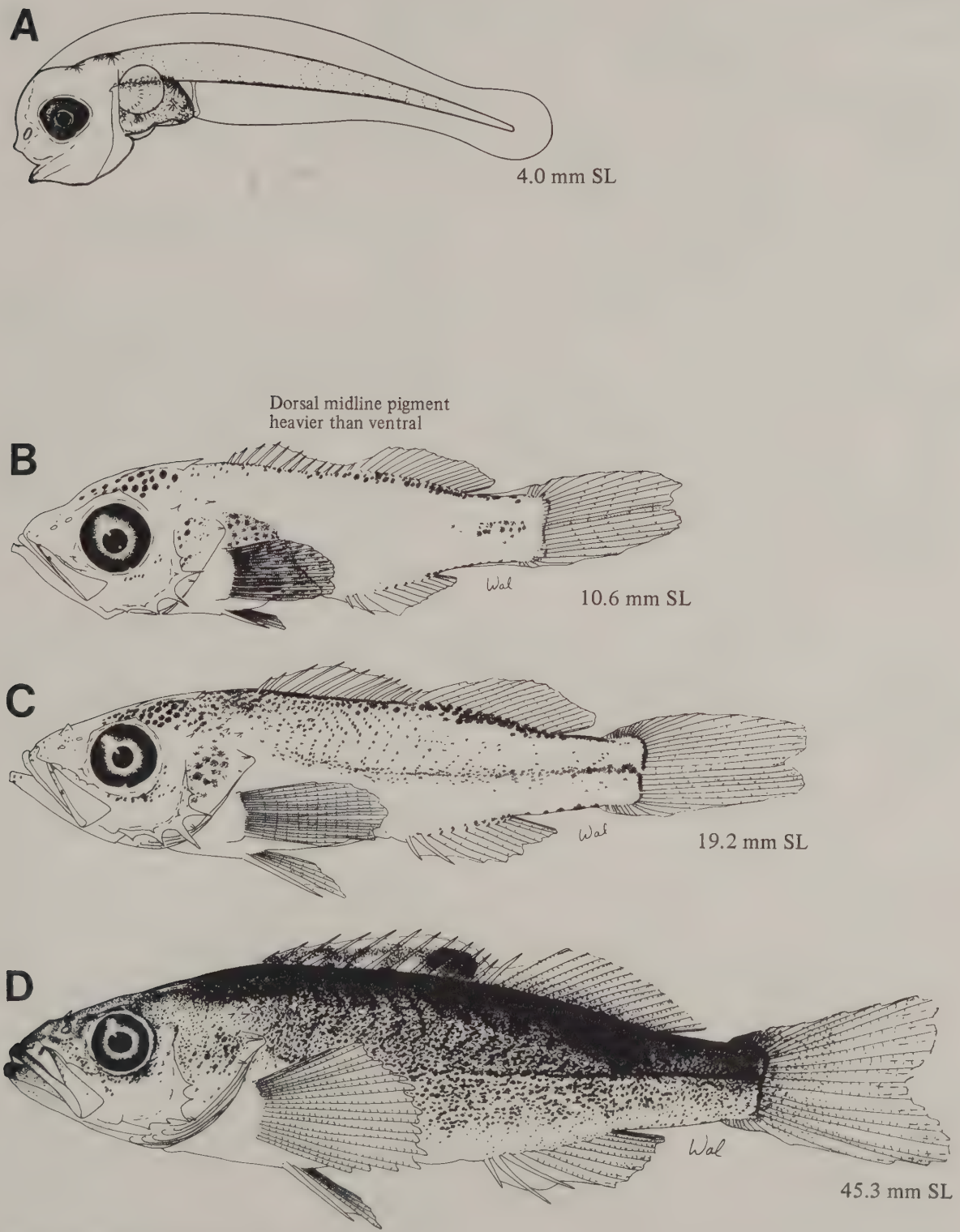



Figure A, NWAFC original (B. Vinter); B–D, Laroche and Richardson 1980.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 26-26-26 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | 9-10, 8+7, 9-11 |
| **Pelvic fin** | Thoracic |
| | S: 1-1-1 R: 5-5-5 |
| **Dorsal fin** | S: 13-13-13 R: 12-13-14 |
| **Pectoral fin** | R: 18-19-20 |
| **Anal fin** | S: 3-3-3 R: 6-7-8 |
| **Gill rakers** | U: 8-X-9 L: 22-22-22 |
| | (T: 30-31-34) |
| **Lateral line pores** | 28-33 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Washington, 46-48°30′N |
| **Ecology** | Epi-, meso-, and bathybenthal, 125-768 m |
| **ELH pattern** | Ovoviviparous, pelagic larvae |
| **Spawning** | Season: Abundance of newborn larvae peaks in February off S. California[a] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | 8 yr (females)[b] |
| **Longevity** | |

## HEAD SPINES

| | |
|---|---|
| **Preocular** | + |
| **Postocular** | + |
| **Coronal** | 0 |
| **Supraocular** | + |
| **Tympanic** | + |
| **Inferior infraorbital** | 2 |

## EARLY LIFE HISTORY DESCRIPTION

### LARVAE

| | |
|---|---|
| **Hatch size** | 4.5 mm SL |
| **Preanal length** | 37% SL increasing with development to 62% SL |
| **Length at flexion** | 6.2-7.2 mm SL |
| **Length at transformation** | ~16 mm SL[c] |
| **Sequence of fin development** | Caudal and pectorals, pelvics, dorsal and anal |

**Pigment**

- Preflexion larvae
  - —Single row postanal ventral midline (~8 spots)
  - —Brain
  - —Lower jaw, streak along upper jaw
  - —Dorsolaterally on gut
  - —Pectoral fin
- Flexion larvae: Opercle blotch and upper jaw streak
- Postflexion and pelagic juveniles: Anterior bar; with development, two additional bars form, under second dorsal and on caudal peduncle

**Diagnostic characters**

- Pigment
  - —Jaw, opercle blotch, postanal bars
  - —Blades of paired fins heavily pigmented
  - —Band of pigment on body centered at about dorsal spine 5-7
- Head spination (see p. 271)
  - —Large serrate parietal spine
  - —Large weakly serrate preopercle angle spine
- Deep bodied (>35% SL)

### PELAGIC JUVENILES

- Banded body pigment extends onto dorsal and anal fins
- Pectoral fin, but not base, pigmented

[a] Moser and Ahlstrom 1978
[b] Wyllie Echeverria 1987
[c] Largest pelagic juvenile collected is 46.2 mm SL; smallest demersal juvenile collected is 36.0 mm SL.

Ref: Laroche, in prep.; Moser and Ahlstrom 1978.

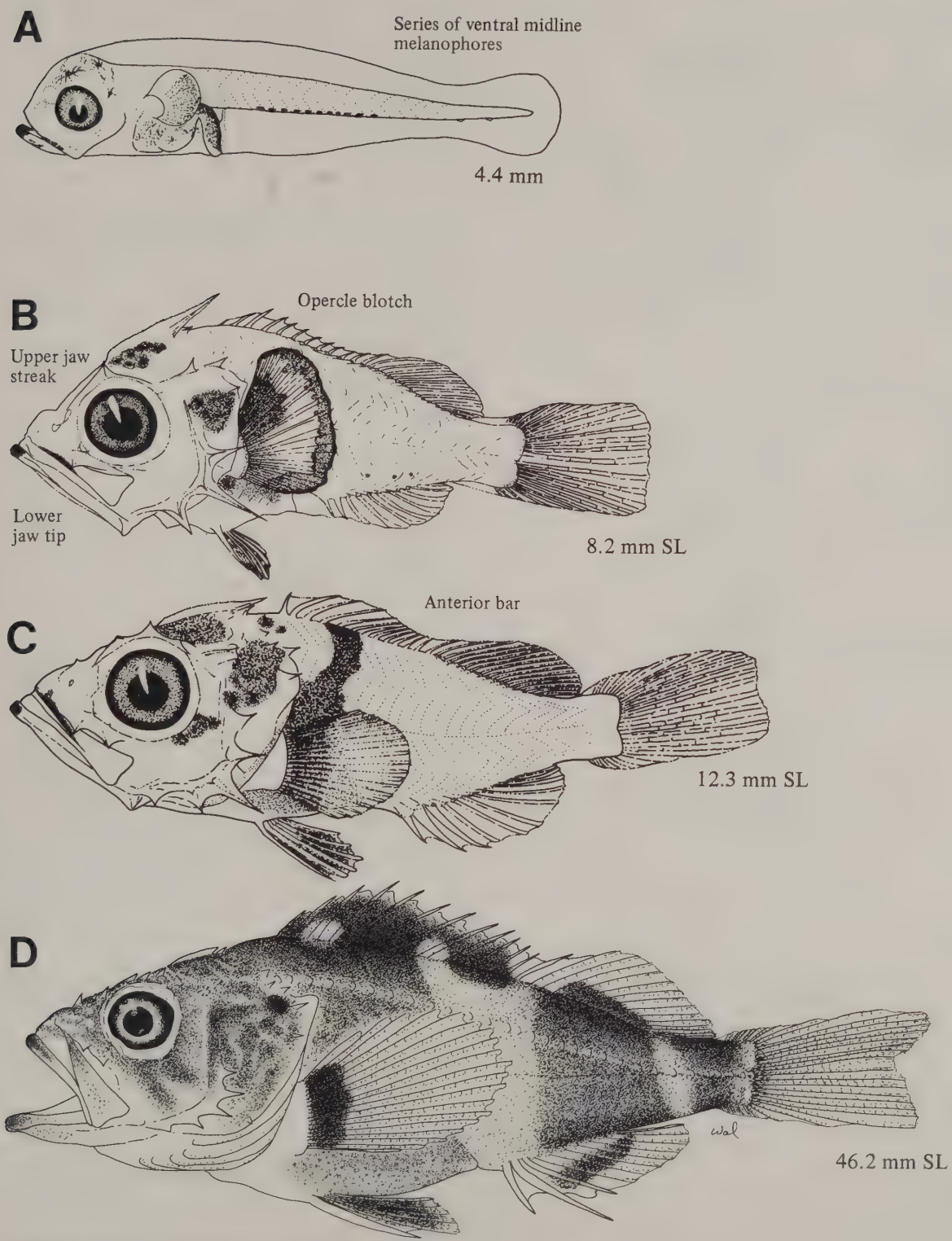



Figure A, Moser et al. 1977; B–C, Moser and Ahlstrom 1978; D, Laroche, in prep.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 26-26-26 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | X, 8+7, X |
| **Pelvic fin** | Thoracic |
| | S: 1-1-1 R: 5-5-5 |
| **Dorsal fin** | S: 13-13-13 R: 13-14-15 |
| **Pectoral fin** | R: 17-18-18 |
| **Anal fin** | S: 3-3-3 R: 6-7-7 |
| **Gill rakers** | U: X-X-X L: X-X-X |
| | (T: 36-41-42) |
| **Lateral line pores** | 41-48 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Brit. Col., 48°30′-55°N |
| **Ecology** | Epi- and mesobenthal, 0-274 m |
| **ELH pattern** | Ovoviviparous, pelagic larvae |
| **Spawning** | Season: Nov-Mar[a] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | 5 yr (females)[b] |
| **Longevity** | |

## HEAD SPINES

| | |
|---|---|
| **Preocular** | + |
| **Postocular** | + |
| **Coronal** | 0 |
| **Supraocular** | + |
| **Tympanic** | + |
| **Inferior infraorbital** | 2 |

## EARLY LIFE HISTORY DESCRIPTION

### LARVAE

**Hatch size** 4.3 mm
**Preanal length**
**Length at flexion**
**Length at transformation**
**Sequence of fin development**
**Pigment**

- Extrusion larvae: Short series midway along ventral body
- Postflexion larvae >12.3 mm SL
  - —Dorsolateral patch under spinous dorsal
  - —Along dorsal and anal fin ray bases
  - —Series along ventral midline toward caudal, becoming internal
  - —Along hypural margin

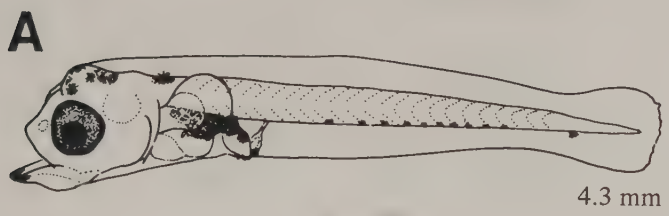
**Diagnostic characters**

### PELAGIC JUVENILES

- Body and head pigment diffuse, heavy
- Pigment blotch on last few dorsal fin spines
- Paired fins pigmented

[a] Phillips 1964
[b] Wyllie Echeverria 1987

Ref: Laroche, in prep.



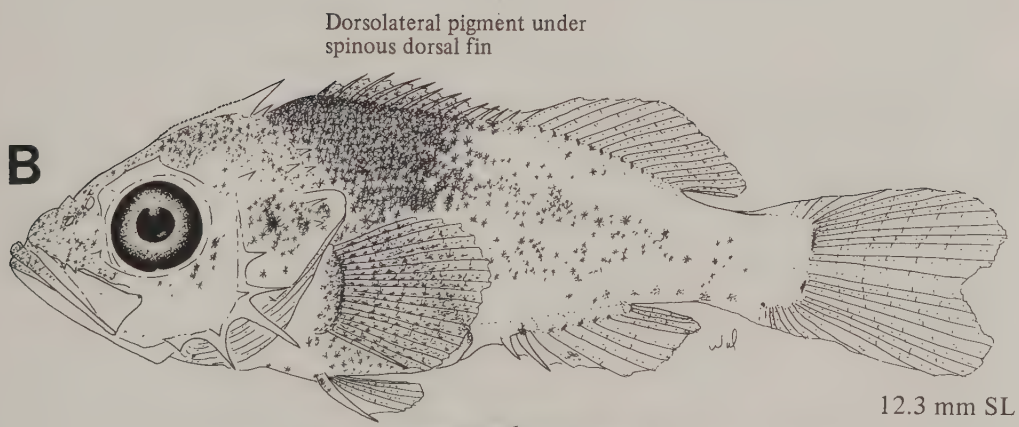



Figure A, Moser et al. 1977; B–C, Laroche, in prep.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 26-26-27 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | X, 8+7, X |
| **Pelvic fin** | Thoracic |
| | S: 1-1-1 R: 5-5-5 |
| **Dorsal fin** | S: 13-13-13 R: 15-16-17 |
| **Pectoral fin** | R: 17-18-19 |
| **Anal fin** | S: 3-3-3 R: 8-9-10 |
| **Gill rakers** | U: 9-10-12 L: 23-25-29 |
| | (T: 32-35-38) |
| **Lateral line pores** | 47-53 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Aleutian Is., 51-55°N |
| **Ecology** | Epi- and mesopelagic, 0-549 m |
| **ELH pattern** | Ovoviviparous, pelagic larvae |
| **Spawning** | Season: Nov-Jan[a] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | 6 yr (females)[b] |
| **Longevity** | |

## HEAD SPINES

| | |
|---|---|
| **Preocular** | + |
| **Postocular** | + |
| **Coronal** | 0 |
| **Supraocular** | + |
| **Tympanic** | + |
| **Inferior infraorbital** | 3 |

## EARLY LIFE HISTORY DESCRIPTION

### LARVAE

**Hatch size** 5.2 mm; 3.8 mm SL[c]
**Preanal length**
**Length at flexion**
**Length at transformation**
**Sequence of fin development**
**Pigment**

- Extrusion larvae: Short series along ventral body[c]
- Preflexion larvae
  - —Spots develop at tip of lower jaw and on pectoral fin blade[c]
  - —Spots form at junction of cleithra
- Postflexion larvae >12.8 mm SL
  - —Along body margins beneath soft dorsal fin and posterior to anal fin
  - —Hypural margin
  - —Internal and external spots along lateral line

**Diagnostic characters**

### PELAGIC JUVENILES

- Body and head pigment diffuse, heavy
- Pigment blotch on last few dorsal fin spines

[a] Wales 1952
[b] Wyllie Echeverria 1987
[c] L. Wold and G. Moreno, Moss Landing Mar. Lab., Moss Landing, CA 95039-0450, pers. commun., 26 July 1988. Drawing (Fig. A) by L. McMasters. Based on results from California Sea Grant Project R/F 115.

Ref: Efremenko and Lisovenko 1970; Laroche, in prep.

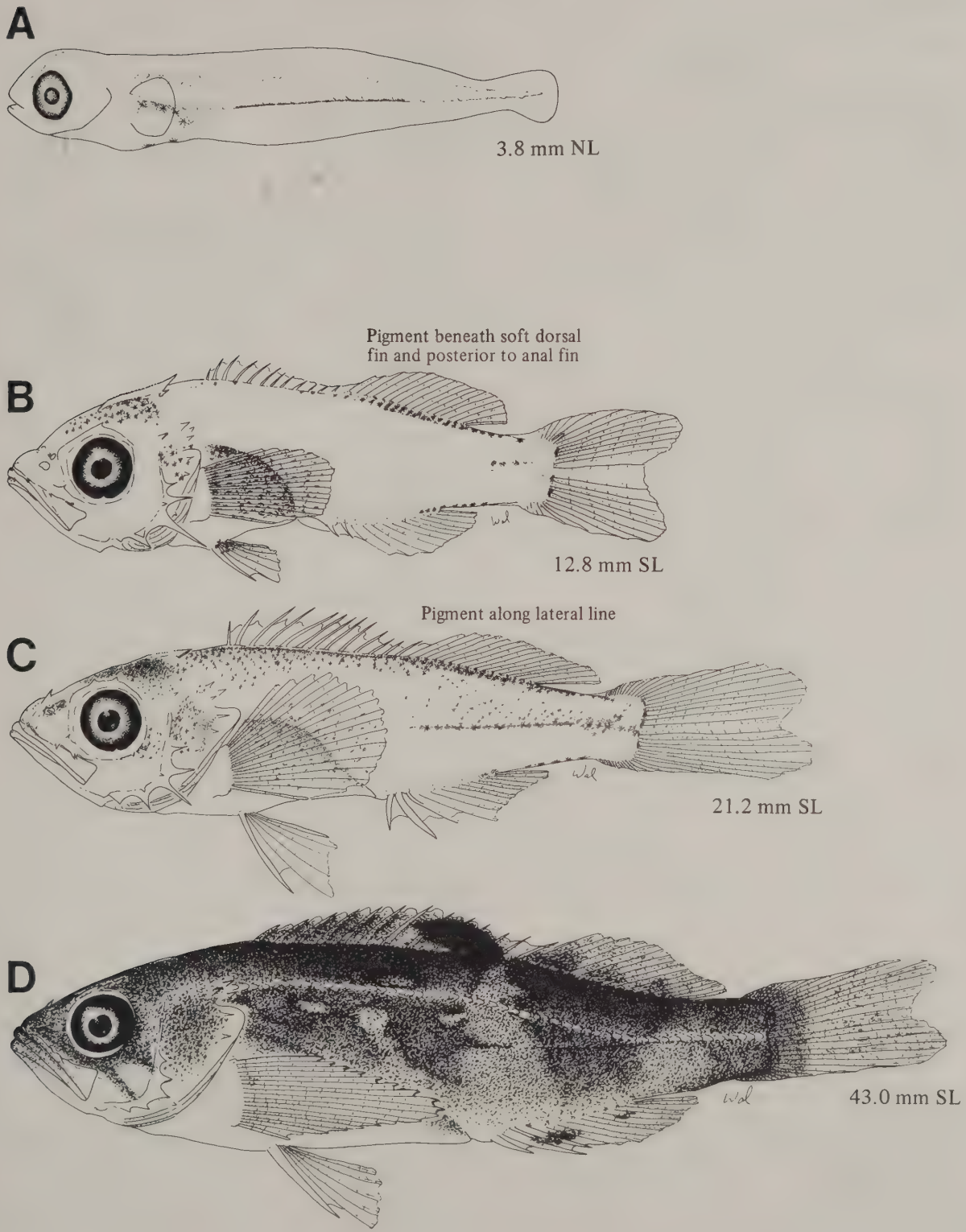



Figure A, Wold, unpubl.; B–D, Laroche, in prep.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 26-26-26 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | X, 8+7, X |
| **Pelvic fin** | Thoracic |
| | S: 1-1-1 R: 5-5-5 |
| **Dorsal fin** | S: 13-13-15 R: 13-14-15 |
| **Pectoral fin** | R: 14-15-16 |
| **Anal fin** | S: 3-3-3 R: 8-9-10 |
| **Gill rakers** | U: 8-8-9 L: 20-21-21 |
| | (T: 27-28-32) |
| **Lateral line pores** | 51-62 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Gulf of Alaska, 54-60°N |
| **Ecology** | Epi- and mesobenthal, 0-475 m |
| **ELH pattern** | Ovoviviparous, pelagic larvae |
| **Spawning** | Season: Jan-Feb;[a] Nov-Apr[b] |
| | Area: Semi-demersal (25-305 m)[c] |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: 20,000[d]-2,440,000[e] (may mature more than one brood per year)[c] |
| **Age at first maturity** | 3-4 yr[d] |
| | 4 yr (females)[f] |
| **Longevity** | 30 yr[g] |
| | 60 yr[h] |

## HEAD SPINES

| | |
|---|---|
| **Preocular** | + |
| **Postocular** | 0 |
| **Coronal** | 0 |
| **Supraocular** | 0 |
| **Tympanic** | + |
| **Inferior infraorbital** | 3-4 |

## EARLY LIFE HISTORY DESCRIPTION

### LARVAE

| | |
|---|---|
| **Hatch size** | 4-5 mm SL |
| **Preanal length** | <50%, with development 50-75% SL |
| **Length at flexion** | 7.2-9.7 mm SL |
| **Length at transformation** | ~15 mm SL |
| **Sequence of fin development** | Caudal and pectorals, pelvics, dorsal and anal |

**Pigment**

- Fringed margins of pectoral and pelvic fins
- Few (6-14) ventral midline melanophores migrate with development to form large patch on caudal peduncle

**Diagnostic characters**

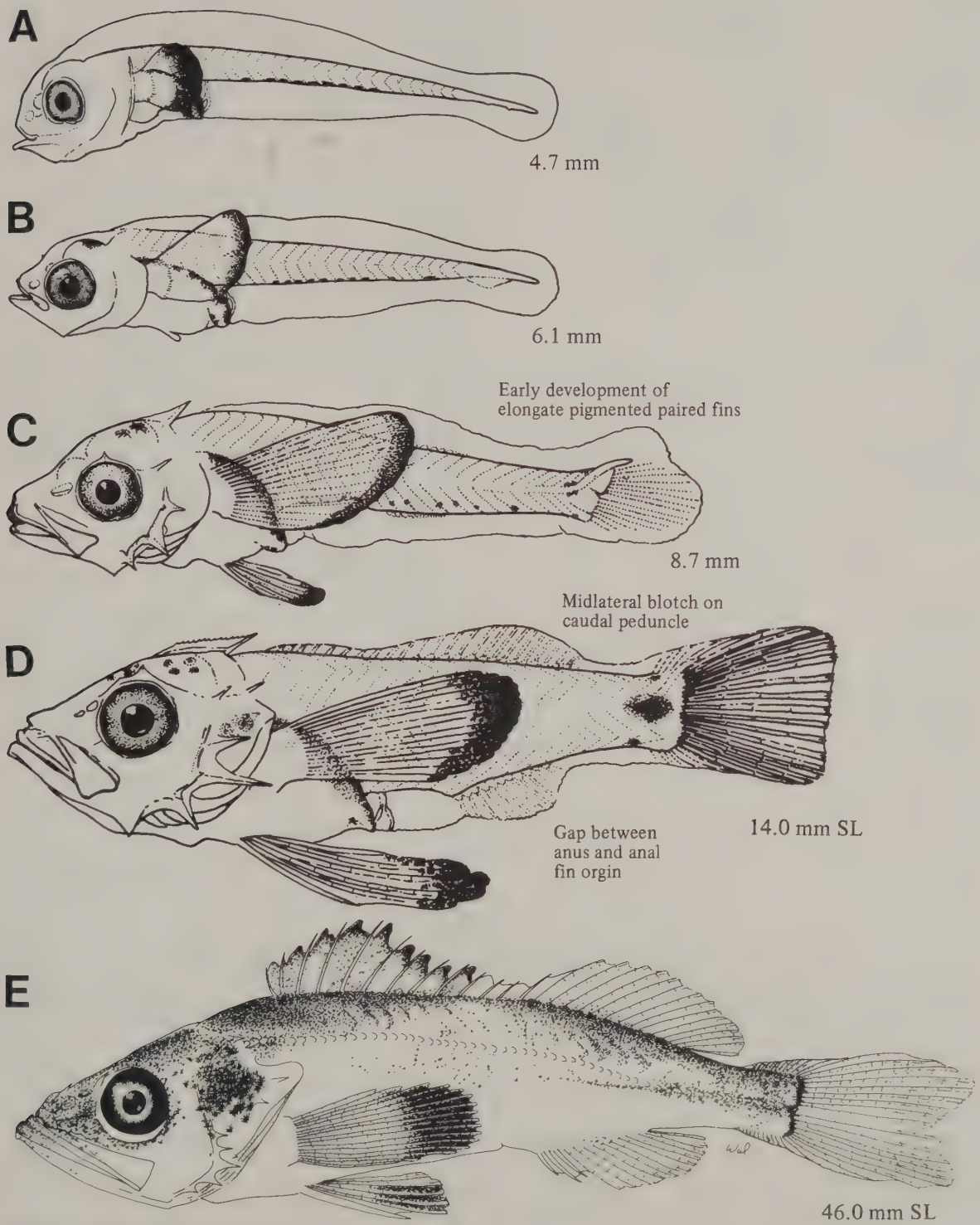
- Early development of elongate pigmented paired fins
- Midlateral pigment blotch on caudal peduncle
- Gap between anus and anal fin origin

### PELAGIC JUVENILES

- Body pigment diffuse, light
- Paired and first dorsal fins heavily pigmented distally

[a] Westrheim 1975
[b] Frey 1971
[c] Moser 1967
[d] Phillips 1964
[e] Gunderson et al. 1980
[f] Wyllie Echeverria 1987
[g] Hart 1973
[h] Beamish 1979

Ref: Laroche, in prep.; Moser 1967; Moser et al. 1977.




Figures A–D, Moser et al. 1977; E, Laroche, in prep.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 26-26-26 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | X, 8+7, X |
| **Pelvic fin** | Thoracic |
| | S: 1-1-1 R: 5-5-5 |
| **Dorsal fin** | S: 13-13-13 R: 13-14-15 |
| **Pectoral fin** | R: 16-17-18 |
| **Anal fin** | S: 3-3-3 R: 7-7-7 |
| **Gill rakers** | U: 12-14-15 L: 26-28-31 |
| | (T: 41-43-44) |
| **Lateral line pores** | 40-47 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Gulf of Alaska, 54-60°N |
| **Ecology** | Epi- and mesobenthal, 0-425 m |
| **ELH pattern** | Ovoviviparous, pelagic larvae |
| **Spawning** | Season: Jan-Mar (Brit. Col.);[a] Nov-Mar (California)[b] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: 260,000-1,897,600[c]/ $F=64221.3\times L-2330029$[d] |
| **Age at first maturity** | 3-5 yr[c] |
| | 9 yr (females)[e] |
| **Longevity** | |

## HEAD SPINES

| | |
|---|---|
| **Preocular** | + |
| **Postocular** | + |
| **Coronal** | 0 |
| **Supraocular** | + |
| **Tympanic** | + |
| **Inferior infraorbital** | 2 |

## EARLY LIFE HISTORY DESCRIPTION

### LARVAE

| | |
|---|---|
| **Hatch size** | 3.6-4.0 mm SL |
| **Preanal length** | 59-64% SL |
| **Length at flexion** | <7.8-8.8 mm SL |
| **Length at transformation** | 12.8-18.4 mm SL[f] |
| **Sequence of fin development** | Caudal and pectorals, pelvics, dorsal and anal |

**Pigment**

- Initially: Lower jaw, ventral surface of gut and posterior gut, short dorsal and ventral midline series at ~3/4 BL between myomeres 18 and 24
- Short dorsal and ventral midline series on caudal peduncle
- Lightly pigmented paired fins
- Head: Dorsal surface; with development, patch also on upper part of opercle
- Paired fins have large melanophores on blades

**Diagnostic characters**

- Pigment: Opercular spot, spots on nape
- Morphology: Deep bodied (~40% SL)
- Spines: Large serrate parietal and third posterior preopercular spine

### PELAGIC JUVENILES

- Body pigment banded, mainly above lateral midline
- Pigment blotch on last few dorsal fin spines, little pigment on rest of fins

[a] Westrheim 1975
[b] Moser 1967
[c] Phillips 1964
[d] Gunderson et al. 1980
[e] Wyllie Echeverria 1987
[f] Larvae are pelagic to 50 mm SL.

Ref: Laroche, in prep.; Moser et al. 1977; Richardson and Laroche 1979; Waldron 1968; Washington et al. 1984b.

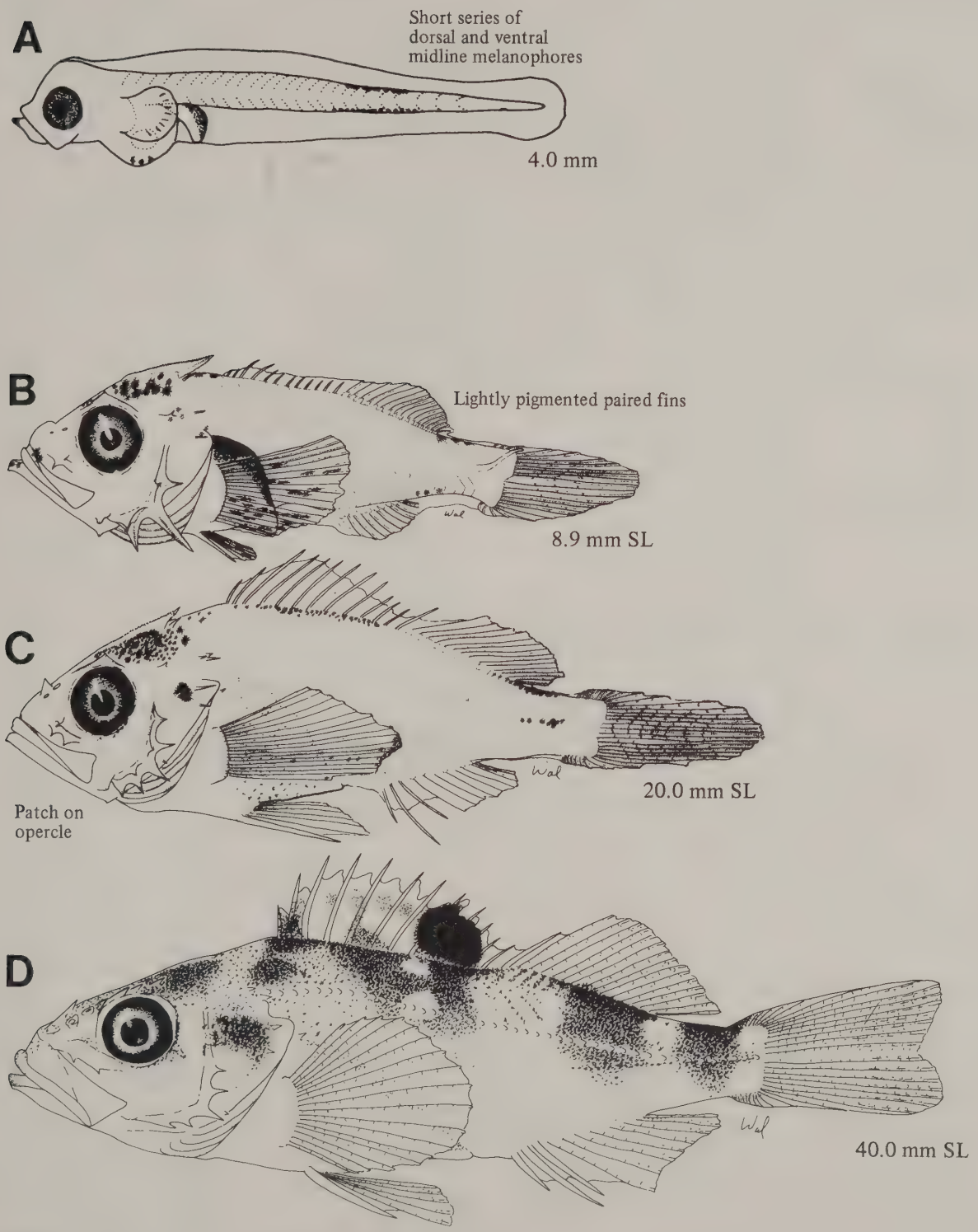



Figure A, Moser et al. 1977; B–C, Richardson and Laroche 1979; D, Laroche, in prep.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 27-27-27 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | X, 8+7, X |
| **Pelvic fin** | Thoracic |
| | S: 1-1-1 R: 5-5-5 |
| **Dorsal fin** | S: 13-13-13 R: 14-15-15 |
| **Pectoral fin** | R: 16-17-17 |
| **Anal fin** | S: 3-3-3 R: 7-7-7 |
| **Gill rakers** | U: 10-11-13 L: 26-27-30 |
| | (T: 36-38-41) |
| **Lateral line pores** | 48-55 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Bering Sea, 54-66°N |
| **Ecology** | Epi- and mesobenthal, 12-274 m |
| **ELH pattern** | Ovoviviparous, pelagic larvae |
| **Spawning** | Season: July[a] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## HEAD SPINES

| | |
|---|---|
| **Preocular** | + |
| **Postocular** | + |
| **Coronal** | 0 |
| **Supraocular** | 0 |
| **Tympanic** | + |
| **Inferior infraorbital** | 2 |

## EARLY LIFE HISTORY DESCRIPTION

### LARVAE

**Hatch size**
**Preanal length**
**Length at flexion**
**Length at transformation**
**Sequence of fin development**
**Pigment**

- Extrusion larvae: Series along ventral body
- Postflexion larvae >16.8 mm SL
  - —On head dorsally
  - —Along dorsal body margin and anal fin ray base
  - —Internal and external spots along lateral midline
  - —Hypural margin

**Diagnostic characters**

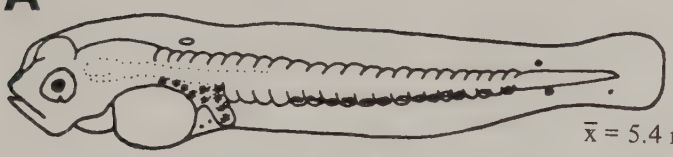
### PELAGIC JUVENILES

- Body elongate, pigment diffuse
- Little fin pigment

[a] Westrheim 1975

Ref: Laroche, in prep.

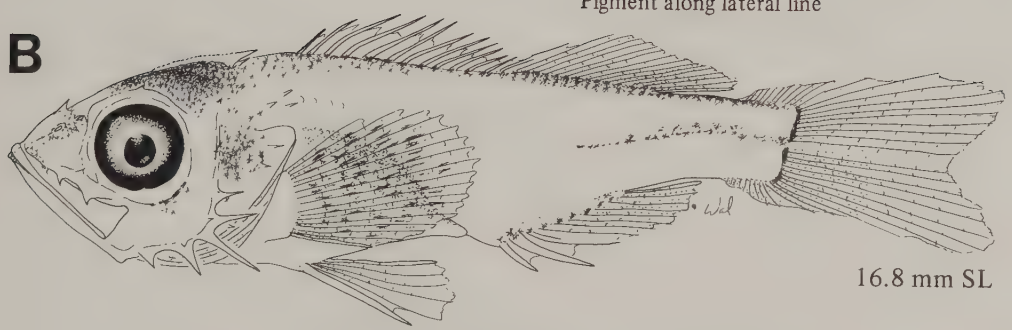
A



$\bar{x}$ = 5.4 mm TL

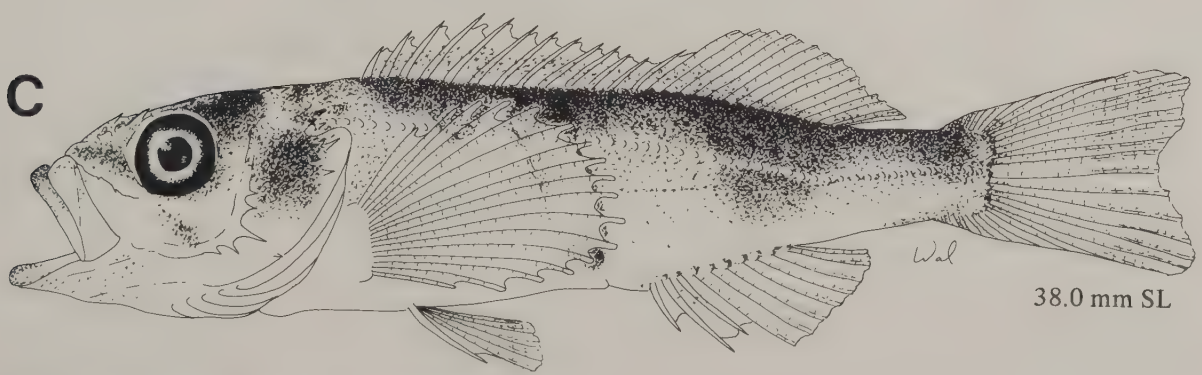
Pigment along lateral line

B



16.8 mm SL

C



38.0 mm SL

Figure A, Westrheim et al. 1968b; B–C, Laroche, in prep.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 26-26-26 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | X, 8+7, X |
| **Pelvic fin** | Thoracic |
| | S: 1-1-1 R: 5-5-5 |
| **Dorsal fin** | S: X-X-X R: 13-14-15 |
| **Pectoral fin** | R: 18-19-20 |
| **Anal fin** | S: 3-3-3 R: 7-7-8 |
| **Gill rakers** | U: 9-10-11 L: 23-24-27 |
| | (T: 30-34-36) |
| **Lateral line pores** | 47-55 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | N. California, 38-42°N, to SE Alaska, 55-59°N |
| **Ecology** | Epi- and mesobenthal, 141-366 m |
| **ELH pattern** | Ovoviviparous, pelagic larvae |
| **Spawning** | Season: Apr[a] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## HEAD SPINES

| | |
|---|---|
| **Preocular** | + |
| **Postocular** | + |
| **Coronal** | 0 |
| **Supraocular** | + |
| **Tympanic** | + |
| **Inferior infraorbital** | 2 |

## EARLY LIFE HISTORY DESCRIPTION

### LARVAE

**Hatch size**
**Preanal length**
**Length at flexion**
**Length at transformation**
**Sequence of fin development**
**Pigment**

- Extrusion larvae: Short series along ventral body
- Postflexion larvae >18.5 mm SL
  - —Dorsally on head
  - —Along dorsal body margin
  - —Hypural margin

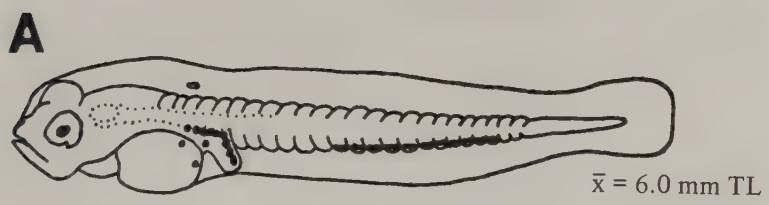
**Diagnostic characters**

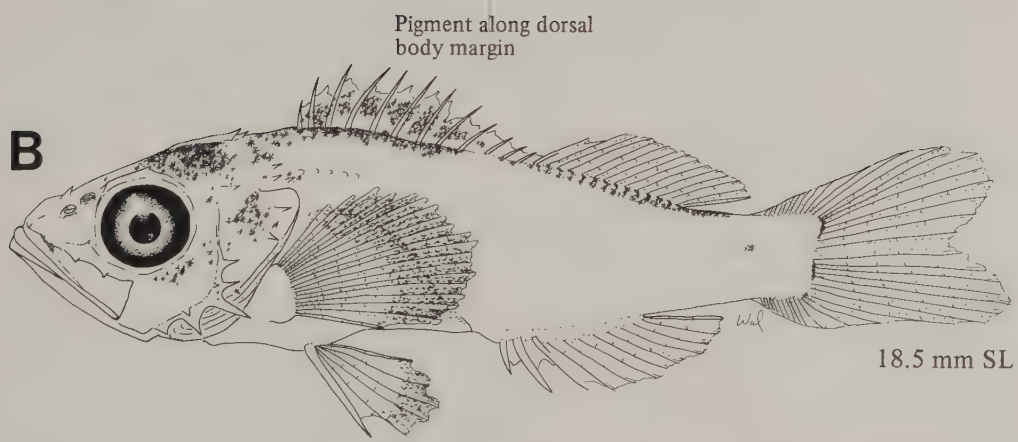
### PELAGIC JUVENILES

- Body pigment banded, heavy
- Fins heavily pigmented

[a] Westrheim 1975

Ref: Laroche, in prep.



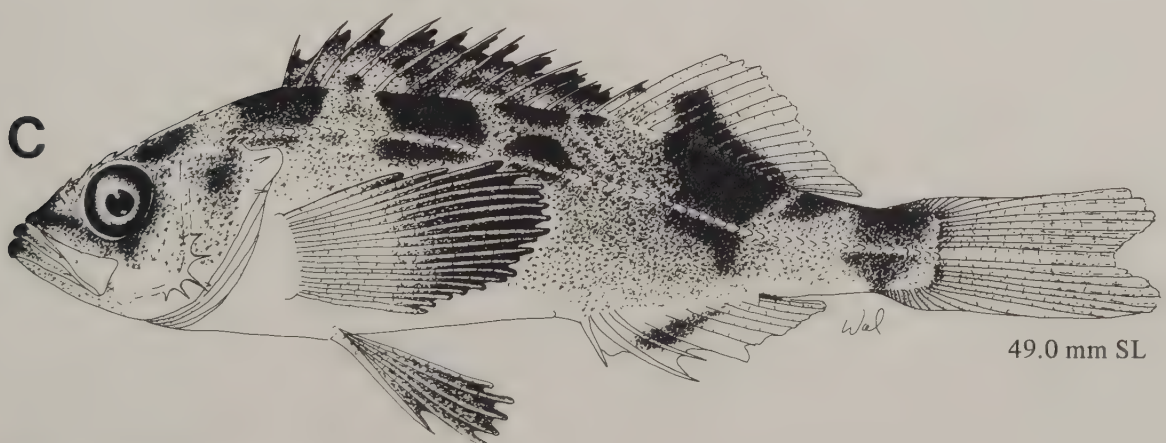




Figure A, Westrheim et al. 1968a; B–C, Laroche, in prep.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 27-27-28 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | 13-14, 8+7, 12-14 |
| **Pelvic fin** | Thoracic |
| | S: 1-1-1 R: 5-5-5 |
| **Dorsal fin** | S: 13-13-13 R: 13-15-16 |
| **Pectoral fin** | R: 17-18-19 |
| **Anal fin** | S: 3-3-3 R: 8-X-9 |
| **Gill rakers** | U: X-X-X L: X-X-X |
| | (T: 32-35-37) |
| **Lateral line pores** | 49-56 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Oregon, 42-46°N[a] |
| **Ecology** | Epi- and mesobenthal |
| **ELH pattern** | Ovoviviparous, pelagic larvae |
| **Spawning** | Season: Dec-May (north-central California)[b] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | 3 yr (females, California)[b] |
| **Longevity** | |

## HEAD SPINES

| | |
|---|---|
| **Preocular** | + |
| **Postocular** | + |
| **Coronal** | 0 |
| **Supraocular** | + |
| **Tympanic** | + |
| **Inferior infraorbital** | 2 |

## EARLY LIFE HISTORY DESCRIPTION

### LARVAE

| | |
|---|---|
| **Hatch size** | 4.3-4.8 mm BL |
| **Preanal length** | 38-43% BL |
| **Length at flexion** | 7.2-7.6 mm BL |
| **Length at transformation** | |
| **Sequence of fin development** | |

**Pigment**

- Increases from extrusion through flexion
- Tip of lower jaw
- Line develops on maxillaries
- Above brain and on nape
- Develops on opercular region
- Short ventral midline series
- Dorsal midline series develops
- Some internal pigment posteriorly above notochord
- Base and blade of pectoral fin

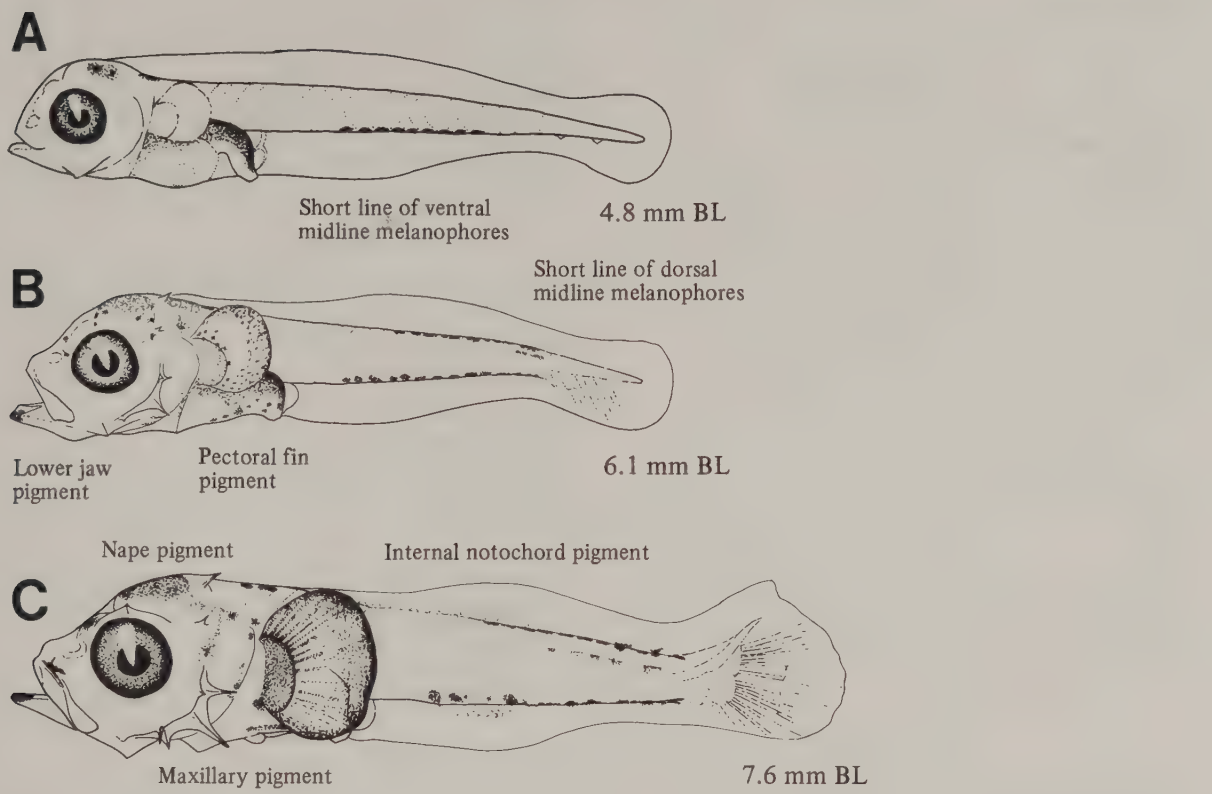
**Diagnostic characters**

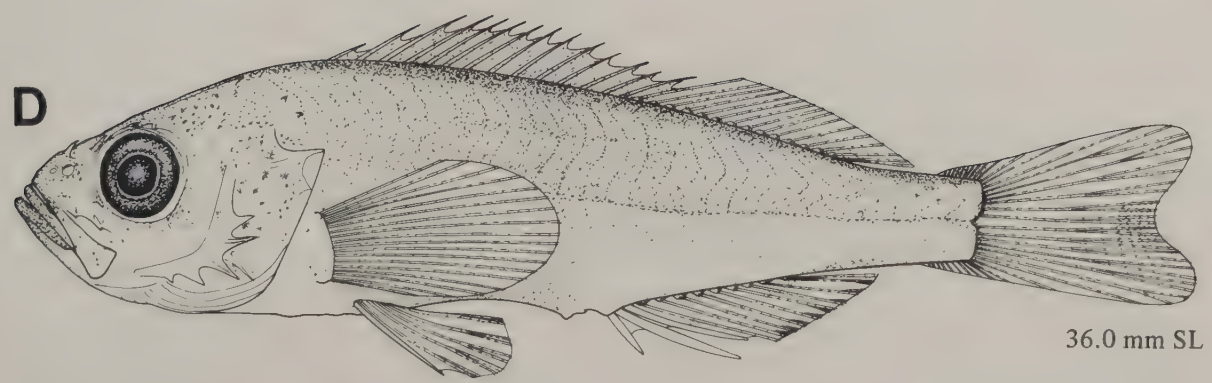
### PELAGIC JUVENILES

- Relatively light, uniform pigment
- Midlateral line pigmented
- Myosepta outlined with pigment

[a] NWAFC meristic database
[b] Wyllie Echeverria 1987

Ref: Moser and Butler 1987.




Figures A–C, Moser and Butler 1987; D, NWAFC original (B. Vinter).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 26-26-26 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | X, 8+7, X |
| **Pelvic fin** | Thoracic |
| | S: 1-1-1 R: 5-5-5 |
| **Dorsal fin** | S: 13-13-13 R: 11-12-13 |
| **Pectoral fin** | R: 16-16-18 |
| **Anal fin** | S: 3-3-3 R: 6-7-7 |
| **Gill rakers** | U: 8-10-10 L: 22-23-26 |
| | (T: 30-32-35) |
| **Lateral line pores** | 35-43 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Gulf of Alaska, 54-60°N |
| **Ecology** | Epi- and mesobenthal, 46-421 m |
| **ELH pattern** | Ovoviviparous, pelagic larvae |
| **Spawning** | Season: Dec-Mar;[a] Feb[b] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: 13,500-230,000[a] |
| **Age at first maturity** | 2-4 yr[a] |
| | 2 yr (females)[c] |
| **Longevity** | |

## HEAD SPINES

| | |
|---|---|
| **Preocular** | + |
| **Postocular** | + |
| **Coronal** | 0 |
| **Supraocular** | 0 |
| **Tympanic** | + |
| **Inferior infraorbital** | 2 |

## EARLY LIFE HISTORY DESCRIPTION

### LARVAE

**Hatch size**
**Preanal length**
**Length at flexion**
**Length at transformation**
**Sequence of fin development**
**Pigment**

- Extrusion larvae: Series along ventral body, shorter series along posterior dorsal midline
- Postflexion larvae >17 mm SL
  —Pigment aligned along epaxial musculature
  —Internal and external spots along lateral midline

**Diagnostic characters**

### PELAGIC JUVENILES

- Body pigment banded
- Median fins pigmented

[a] Phillips 1964
[b] Westrheim 1975
[c] Wyllie Echeverria 1987

Ref: Laroche, in prep.

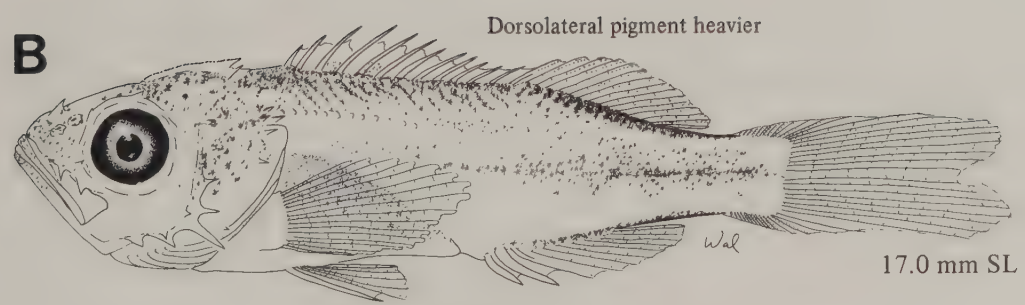


Figure A, Moser et al. 1977; B–C, Laroche, in prep.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 27-27-27 |
| | Precaudal: X-X-X |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | X, 8+7, X |
| **Pelvic fin** | Thoracic |
| | S: 1-1-1 R: 5-5-5 |
| **Dorsal fin** | S: 13-13-13 R: 13-14-15 |
| **Pectoral fin** | R: 16-17-18 |
| **Anal fin** | S: 3-3-3 R: 7-7-8 |
| **Gill rakers** | U: 9-10-11 L: 23-25-27 |
| | (T: 33-35-37) |
| **Lateral line pores** | 39-47 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Gulf of Alaska, 54-60°N |
| **Ecology** | Epi- and mesobenthal, 25-475 m |
| **ELH pattern** | Ovoviviparous, pelagic larvae |
| **Spawning** | Season: July (British Columbia)[a] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## HEAD SPINES

| | |
|---|---|
| **Preocular** | + |
| **Postocular** | + |
| **Coronal** | 0 |
| **Supraocular** | 0 |
| **Tympanic** | + |
| **Inferior infraorbital** | 2 |

## EARLY LIFE HISTORY DESCRIPTION

### LARVAE

| | |
|---|---|
| **Hatch size** | 4.3 mm SL |
| **Preanal length** | 50-75% SL |
| **Length at flexion** | 7.4-9.0 mm SL |
| **Length at transformation** | ~13.5-20.0 mm SL; 13.7-19.6 mm[b,c] |
| **Sequence of fin development** | Caudal and pectorals, pelvics, dorsal and anal |

**Pigment**

- Extrusion larvae: Posterior gut, along ventral midline, and on head
- Larvae >7.4 mm SL: A few melanophores along ventral midline, head, and dorsal gut
- Postflexion larvae >12.7 mm SL: Along dorsal midline and fin base, on caudal peduncle

**Diagnostic characters**

- Moderately pigmented pectorals and pelvics
- Lack of body pigment
- Long, deeply serrate parietal spine and posterior preopercular spine
- Little ventral postanal midline pigment
- Development of dorsal midline pigment (>10 mm SL)
- Large head (>40% SL), deep body (>30% SL)

### PELAGIC JUVENILES

- Body pigment diffuse, lateral midline pigmented
- Little fin pigment

[a] Westrheim 1975
[b] Washington et al. 1984b
[c] Juveniles are pelagic to 65 mm SL, although they may become demersal at 35 mm SL.

Ref: Laroche, in prep.; Laroche and Richardson 1981; Westrheim 1975.

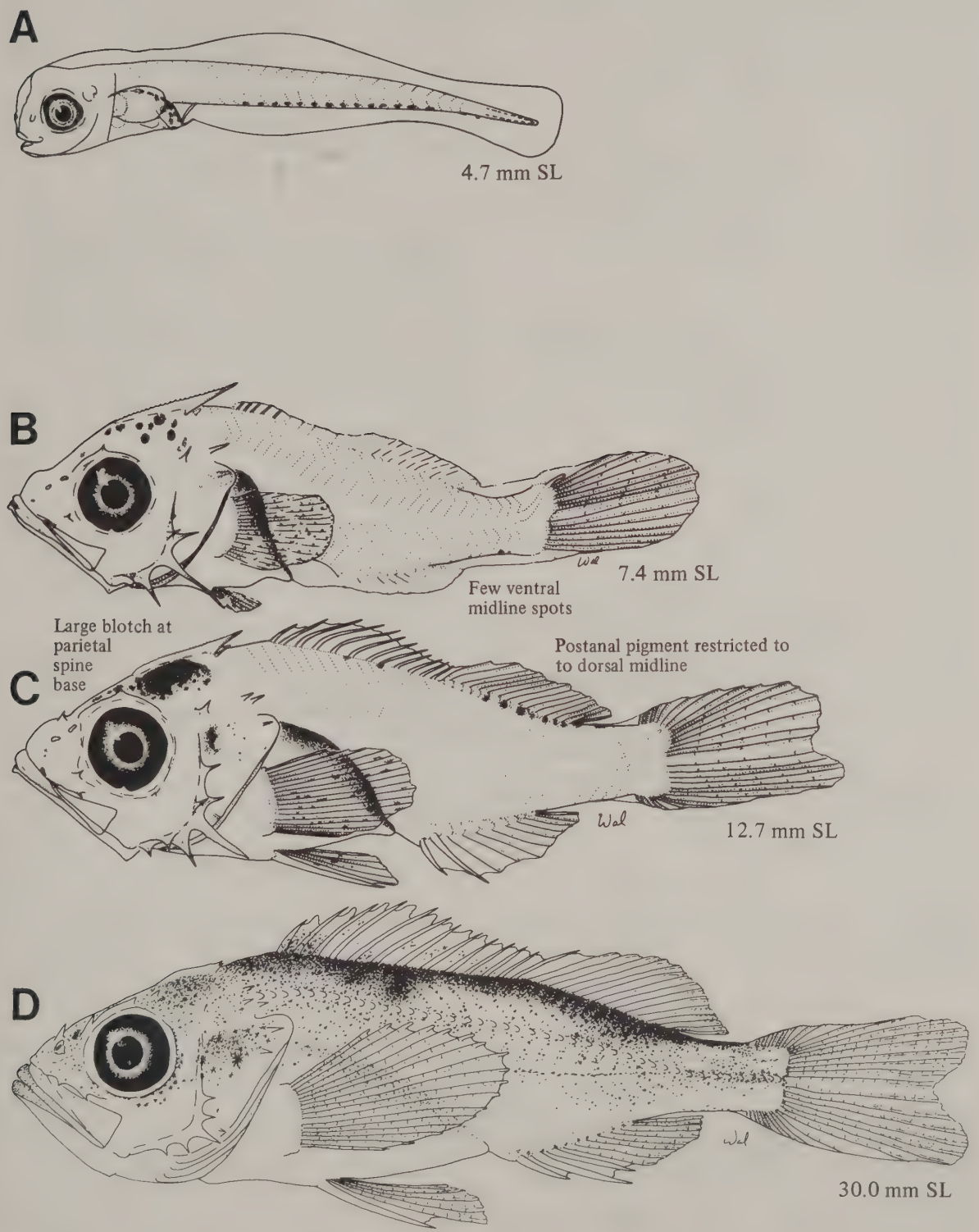



Figure A, NWAFC original (B. Vinter); B–C, Laroche and Richardson 1981; D, Laroche, in prep.

## MERISTICS *S. alascanus* Bean 1890

| | | |
|---|---|---|
| **Vertebrae** | Total: 29-30-31 | |
| | Precaudal: 10-10-11 | |
| | Caudal: 18-20-21 | |
| **Branchiostegal rays** | 7-7-7 | |
| **Caudal fin** | X, 8+8, X | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 5-5-5 |
| **Dorsal fin** | S: 14-16-17 | R: 8-9-10 |
| **Pectoral fin** | R: 20-21-23 | |
| **Anal fin** | S: 3-3-3 | R: 3-5-5 |
| **Gill rakers** | U: 5-6-8 | L: 12-14-17 |

## MERISTICS *S. altivelis* Gilbert 1896

| | | |
|---|---|---|
| **Vertebrae** | Total: 28-X-29 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 7-7-7 | |
| **Caudal fin** | X, 8+8, X | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 5-5-5 |
| **Dorsal fin** | S: 15-X-16 | R: 8-X-10 |
| **Pectoral fin** | R: 22-X-24 | |
| **Anal fin** | S: 3-3-3 | R: 4-X-6 |
| **Gill rakers** | U: 7-X-9 | L: 14-X-17 |

## MERISTICS *S. macrochir* Günther 1880

| | | |
|---|---|---|
| **Vertebrae** | Total: 29-29-29 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 7-7-7 | |
| **Caudal fin** | X, 8+7, X | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 5-5-5 |
| **Dorsal fin** | S: 15-15-16 | R: 8-X-10 |
| **Pectoral fin** | R: 22-X-23 | |
| **Anal fin** | S: 3-3-3 | R: 5-5-5 |
| **Gill rakers** | U: 7-X-8 | L: 13-X-14 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Bering Sea, 54-66°N[a] |
| **Ecology** | Benthal[b] |
| **ELH pattern** | Oviparous; gelatinous, pelagic egg masses;[c] pelagic larvae |
| **Spawning** | Season: Jan-June (California);[d] spring (Oregon)[c] |

## EARLY LIFE HISTORY DESCRIPTION

### LARVAE - Genus[e]

| | |
|---|---|
| **Preanal length** | <50%, with development increasing to 50-75% SL |
| **Length at flexion** | 6.0-7.5 mm SL |
| **Length at transformation** | 14-20 mm SL[f] |
| **Sequence of fin development** | Pectorals; caudal; dorsal, anal, and pelvics |

**Pigment** - Genus

- Postanal band that disappears with development
- Pectoral fins pigmented at fringes
- Body lacks pigment from ~6-12 mm SL

**Diagnostic characters**

- <10.0 mm SL: Not separable to species
- >10.0 mm SL: *S. alascanus* less robust, shorter, and with fewer pectoral rays than *S. altivelis*

Distinguished from *Melamphaes lugubris* (p. 254) at sizes <5 mm SL by

- Postanal pigment band more posterior, beginning about myomere 20
- Pelvic fin not precocious in *Sebastolobus* spp.

[a] *S. macrochir* found only in the Bering Sea.
[b] *S. alascanus* epi-, meso-, and bathybenthal (26-1524 m); *S. altivelis* meso- and bathybenthal (305-1524 m); *S. macrochir* mesobenthal.
[c] Pearcy 1962
[d] Moser 1974
[e] Larvae of *S. macrochir* are unknown.
[f] Juveniles are pelagic to 42-56 mm SL.

Ref: Moser 1974, Moser et al. 1977, Washington et al. 1984b.

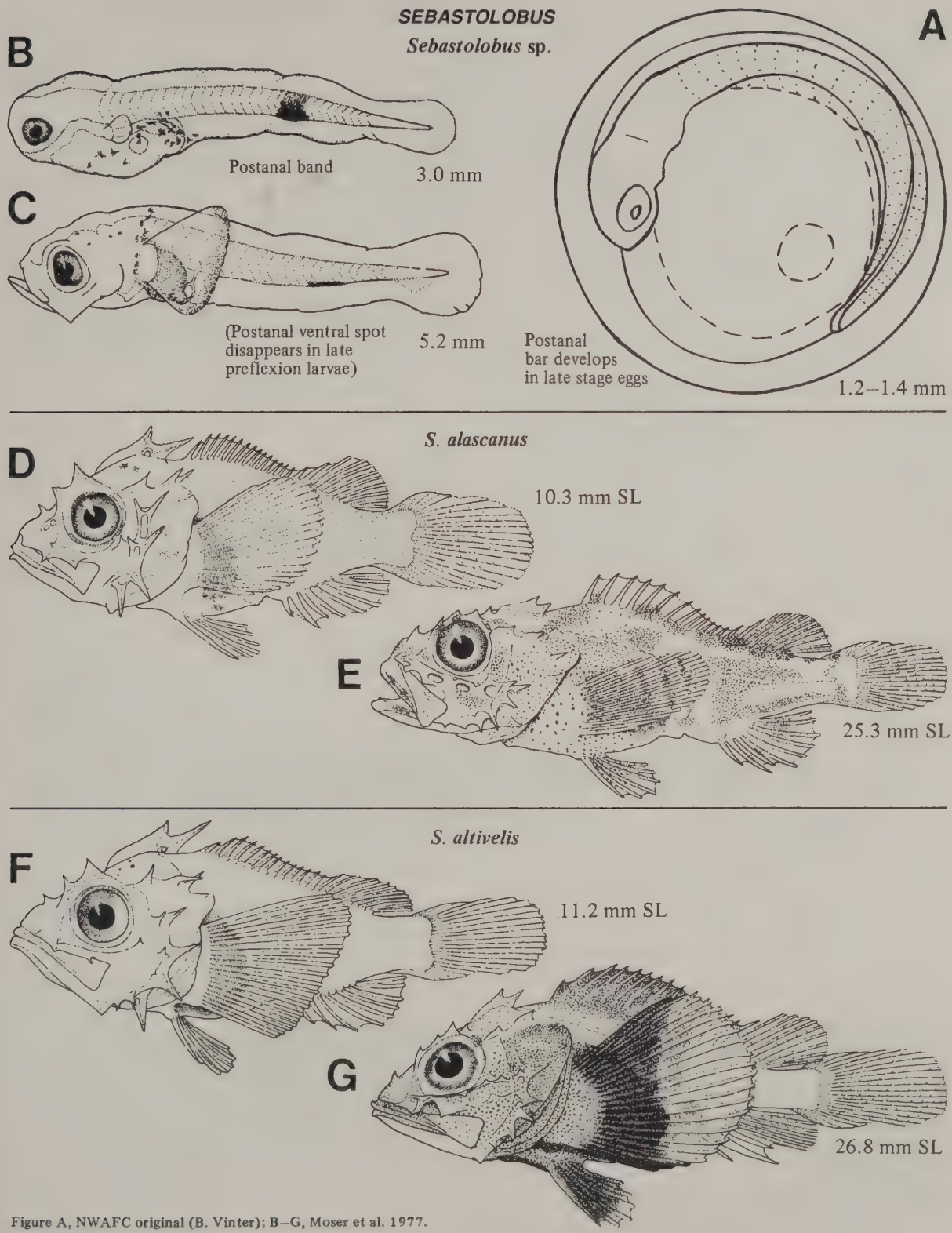



Figure A, NWAFC original (B. Vinter); B–G, Moser et al. 1977.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 61-63-66 | |
| | Precaudal: 29-31-33 | |
| | Caudal: 31-33-34 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | X, 7+7, X | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 5-5-5 |
| **Dorsal fin** | S: 17-22-30 | R: 16-18-21 |
| **Pectoral fin** | R: 14-14-14 | |
| **Anal fin** | S: 2-X-3 | R: 15-19-23 |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Bering Sea, 54-66°N |
| **Ecology** | Epi-, meso-, and bathybenthal, 0 (juveniles) - 2740 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Dec-Apr (California);[a] Sept-Apr (Oregon-Brit.Col.);[b] fall-summer (Bering Sea)[b] |
| | Area: Pelagic (175-1450 m)[b] |
| | Mode: |
| | Migration: To deeper water[c] |
| **Fecundity** | Range/function: 100,000[a]-1,300,000[d] |
| **Age at first maturity** | 5-7 yr[d] |
| **Longevity** | 55 yr[e] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 2.05-2.10 mm |
| **No. of oil globules** | None |
| **Yolk** | Homogeneous |
| **Envelope** | Smooth, unsculptured |
| **Hatch size** | 6 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

- Unpigmented embryo

**Diagnostic characters**

- Narrow perivitelline space
- Unpigmented embryo with high myomere count and long gut
- No oil globule
- Large size (2.05-2.10 mm)

### LARVAE

| | |
|---|---|
| **Preanal length** | 50-60% SL |
| **Length at flexion** | ~12.0 mm SL |
| **Length at transformation** | |
| **Sequence of fin development** | Caudal, pectorals, 2nd dorsal (rays) and anal, 1st dorsal (spines), pelvics |

**Pigment**

- Initially unpigmented
- Preflexion larvae develop dorsal and ventral midline pigment
- Flexion and later larvae are heavily and uniformly pigmented

**Diagnostic characters** (see Table 3)

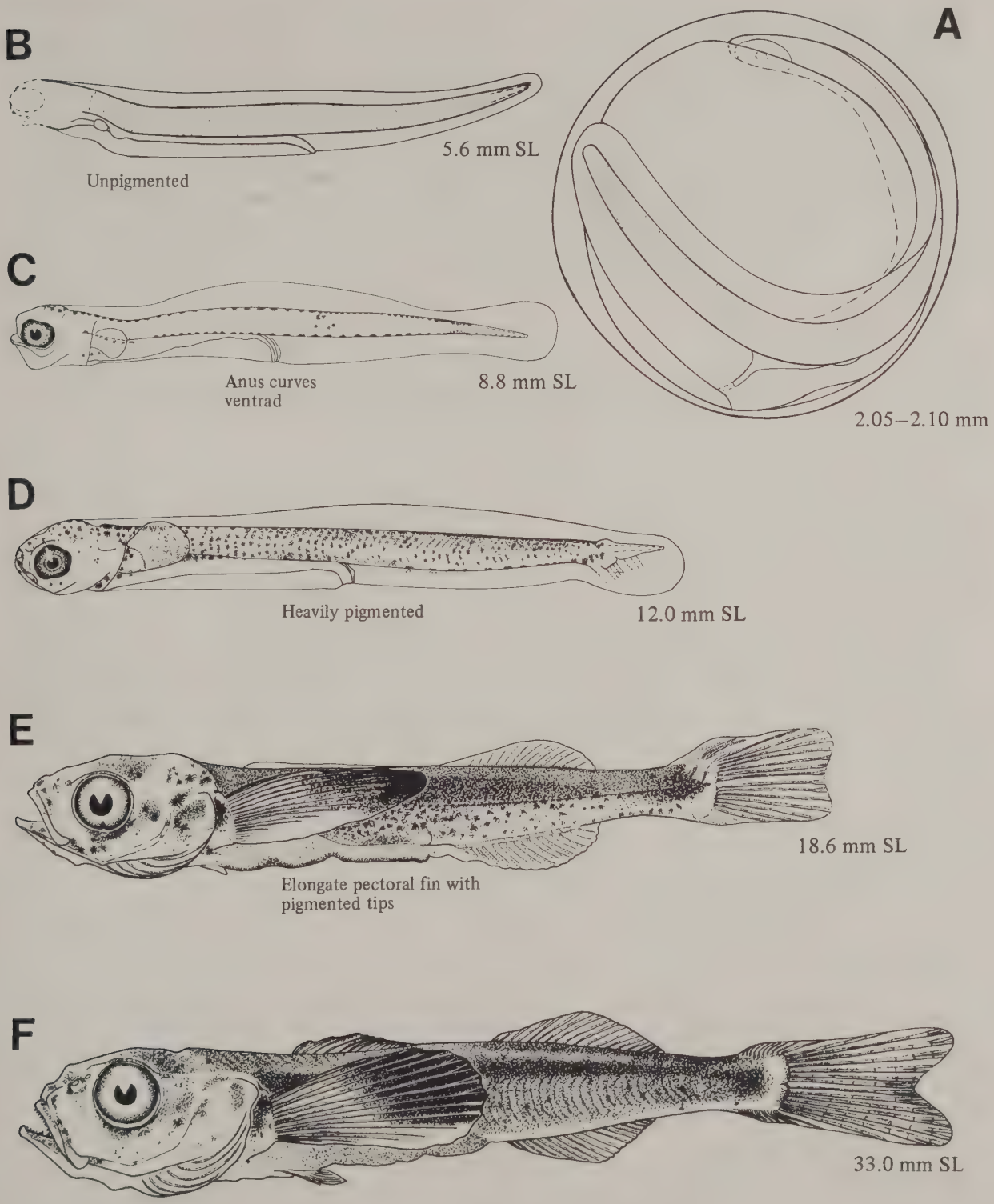
- Slender, heavily pigmented larvae (flexion)
- Long preanal length (50-60% SL)
- >15 mm SL: long pigmented pectoral fins
- Separate dorsal fins (larger larvae)

Larvae of *Erilepis zonifer* (skilfish), an anoplopomatid from the study area, are unknown. The following meristics distinguish them from *A. fimbria*.

| | |
|---|---|
| Total vertebrae | 45-46 |
| Dorsal fin rays | XII-XVI, 15-19 |
| Pectoral fin rays | 16-19 |
| Anal fin rays | III, 11-14 |

[a] Phillips and Imamura 1954
[b] Mason et al. 1983
[c] Kendall and Matarese 1987
[d] Alton and Webber 1976
[e] McFarlane and Beamish 1983

Ref: Ahlstrom and Stevens 1976, Kendall and Matarese 1987.




Figures A–D, Kendall and Matarese 1987; E–F, Ahlstrom and Stevens 1976.

### Hexagrammidae

The greenlings, endemic to the North Pacific Ocean, are composed in our area of nine species in five genera. Most adult greenlings are demersal and occur nearshore; however, larvae commonly occur off the continental shelf. Eggs are demersal and are usually guarded in nests. Development from hatching to juvenile is direct without any marked transformation. An epipelagic juvenile stage occurs in most species. Larvae are heavily pigmented with scattered melanophores over most of the body, especially dorsally. Characters that will distinguish hexagrammids from other heavily pigmented larvae are presented in Table 3. Identification is accomplished using a combination of pigment and meristic characters along with geographic occurrence. *Oxylebius pictus* and *Zaniolepis* spp. larvae have lower vertebral counts, larger pectoral fins with heavier pigment, and differ from other genera in a number of morphological features (e.g., larger heads, longer preanal length, and deeper bodies). *Ophiodon elongatus* larvae can be separated by the presence of a pointed snout and a large terminal mouth. *Pleurogrammus monopterygius* larvae lack pigment on the snout which serves to distinguish them from larvae of *Hexagrammos* spp. Differences among the larvae of the various species of *Hexagrammos* spp. are discussed in Tables 34-35 and illustrated on page 351.

**Table 32**

**Meristic characters of Northeast Pacific hexagrammids. For all species the normal count for branchiostegal rays is 6 and for pelvic fin rays is I,5 (Kendall and Vinter 1984).**

| | | | | Fin rays | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Dorsal | | | | Caudal | | | | |
| | Vertebrae | | | | | | | Dorsal | | Ventral | | Gill rakers |
| Species | Precaudal | Caudal | Total | First (spines) | Second (soft rays) | Total anal* | Pectoral | Secondary | Principal | Principal | Secondary | First arch |
| *Oxylebius pictus* | 13-15 | 23-25 | 36-40 | 15-17 | 13-16 | 14-17 | 14-17 | 9 | 7 | 6 | 9 | 11-14 |
| *Zaniolepis frenata* | 14-15 | 26-28 | 40-43 | 21 | 12 | 18-19 | | | | | | |
| *Zaniolepis latipinnis* | 14 | 28 | 42 | 21-22 | 11-12 | 18-20 | 14 | 6-8 | 7 | 6 | 7-9 | 11-12 |
| *Ophiodon elongatus* | 23-24 | 33-35 | 56-59 | 25-28 | 19-21 | 21-25 | 16-18 | 13-15 | 7 | 7 | 12-14 | 19-28 |
| *Pleurogrammus monopterygius* | 26-28 | 32-35 | 58-63 | 21-24 | 24-30 | 23-28 | 23-28 | 16-19 | 8 | 11 | 16-20 | 22-27 |
| *Hexagrammos decagrammus* | 20-22 | 33-35 | 52-57 | 21-23 | 22-26 | 23-26 | 18-20 | 12-16 | 7 | 9 | 12-14 | 15-20 |
| *Hexagrammos lagocephalus* | 20-23 | 32-34 | 52-57 | 20-23 | 20-25 | 21-24 | 18-21 | 17-22 | 7 | 10 | 15-19 | 14-18 |
| *Hexagrammos octogrammus* | 18-19 | 32-35 | 50-54 | 18-20 | 22-25 | 23-26 | 18-19 | 15-17 | 7 | 8 | 14-15 | 14-17 |
| *Hexagrammos stelleri* | 20-22 | 31-34 | 51-56 | 22-25 | 18-22 | 22-25 | 18-20 | 16-17 | 7 | 8 | 14-15 | 16-20 |

*Anal spines are very weak in *Pleurogrammus* and *Hexagrammos*, therefore only total anal fin elements are given for these taxa. Counts for anal spines in specific taxa are given on the individual text pages.

**Table 33**

**Larval characters that allow distinction between *Oxylebius pictus* and *Zaniolepis* spp. (Kendall and Vinter 1984).**

| | *Oxylebius pictus* | *Zaniolepis* spp. |
|---|---|---|
| **3-7 mm SL** | | |
| Presence of pigment | | |
| On isthmus | No | Yes |
| Laterally above gut | Less | More |
| On ventral midline of trunk | More | Less |
| On tip of snout and onto tip of palate | No | Yes |
| On internal surface of pectoral fin base | Yes | No |
| On lower lip | No | Sometimes |
| Morphology | | |
| Eye size | Smaller (<20% head length) | Larger (>30% head length) |
| Preanal finfold (5 to 8 mm) | No | Yes |
| Pectoral fin length | Reaches anus by 8.0 mm | Reaches anus by 5.5 mm |
| Notochord flexion | 7-9 mm | 5-7 mm |
| Dorsal indentation on eye | No | Yes |
| **>7 mm SL** | | |
| Spiny scales cover body | No | Yes |
| Body depth | Stout (<30% SL) | Slender (<25% SL) |

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 36-X-40 | |
| | Precaudal: 13-13-15 | |
| | Caudal: 23-24-25 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | 9, 7+6, 9 | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 5-5-5 |
| **Dorsal fin** | S: 15-X-17 | R: 13-X-17 |
| **Pectoral fin** | R: 14-X-17 | |
| **Anal fin** | S: 3-X-4 | R: 12-X-14 |
| **Gill rakers** | U: 2-X-5 | L: 7-X-8 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Gulf of Alaska, 54-60°N |
| **Ecology** | Nearshore shelf demersal, intertidal to 49 m |
| **ELH pattern** | Oviparous; demersal, adhesive eggs; pelagic larvae |
| **Spawning** | Season: May-Aug (Puget Sound);[a] Oct-July (Calif.)[b]<br>Area: Demersal, on or near rocks[b]<br>Mode: Eggs guarded by male; may have three breeding cycles/season[b]<br>Migration: |
| **Fecundity** | Range/function: 12,000-28,000/<br>$F=0.0338\times L^{2.114}$,<br>L=TL mm (Shilshole breakwater, Washington);<br>$F=0.003\times L^{2.628}$,<br>L=TL mm (Monterey, Calif.)[b] |
| **Age at first maturity** | 3 yr (females)[b]<br>2 yr (males)[b] |
| **Longevity** | >8 yr[c] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | 4-5 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 54-64% SL |
| **Length at flexion** | 7-9 mm SL |
| **Length at transformation** | 16-20 mm SL |
| **Sequence of fin development** | Pectorals, caudal, 2nd dorsal (rays) and anal, 1st dorsal (spines) and pelvics |

**Pigment**

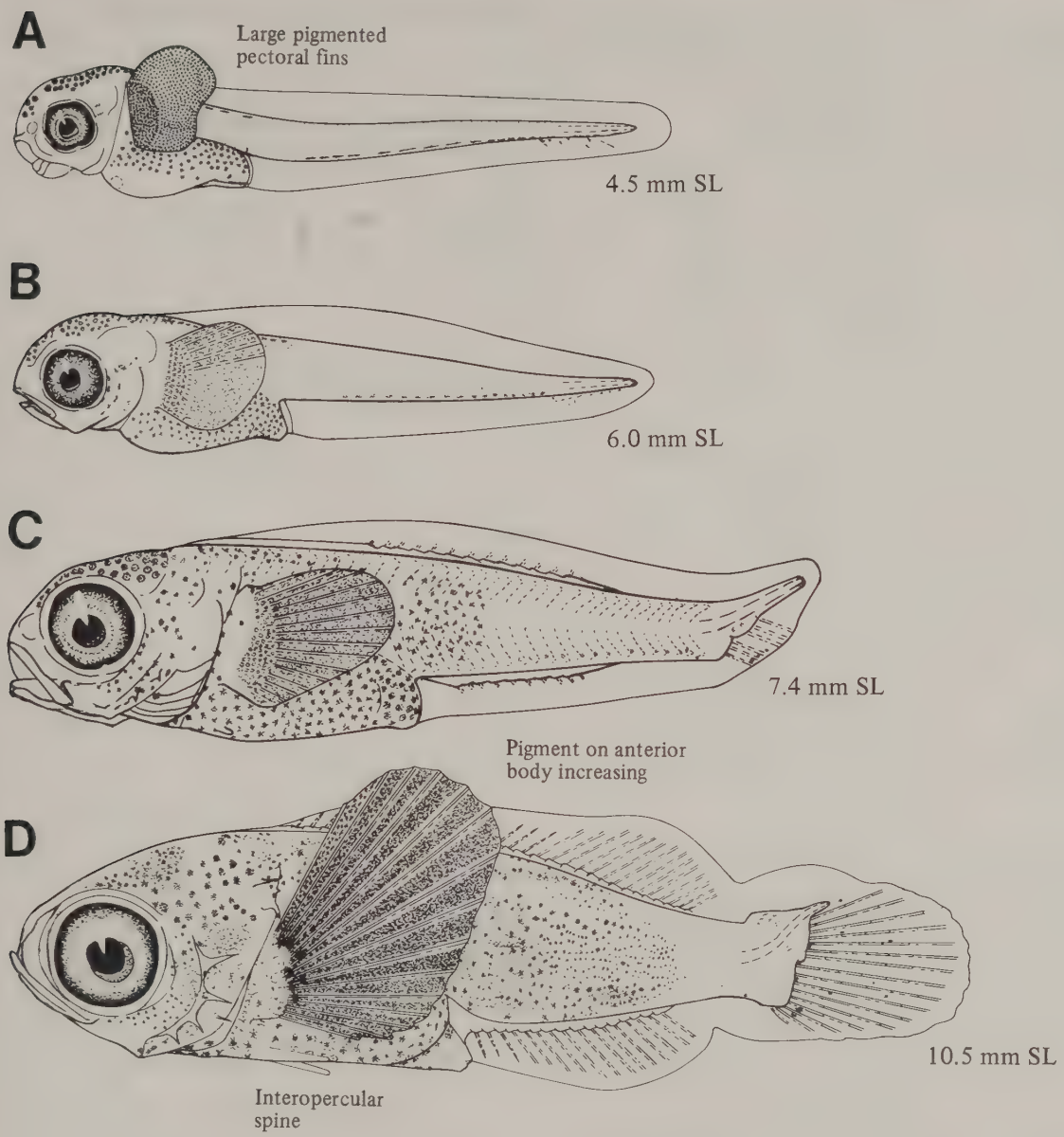
- Pectoral fin
- Ventral midline
- Dorsolateral on gut
- Flexion larvae with increased pigment on anterior body

**Diagnostic characters**

- See Table 33 for characters that allow separation from *Zaniolepis* spp.
- Large pigmented pectoral fins

[a] Patten 1980
[b] DeMartini 1976
[c] Fitch and Lavenberg 1975

Ref: Kendall and Vinter 1984.




Figures A–D, Kendall and Vinter 1984.

## MERISTICS — *Z. frenata* Eigenmann and Eigenmann 1889

| | | |
|---|---|---|
| **Vertebrae** | Total: 40-X-43 | |
| | Precaudal: 14-14-15 | |
| | Caudal: 26-28-28 | |
| **Branchiostegal rays** | 6-X-7 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 5-5-5 |
| **Dorsal fin** | S: 21-21-21 | R: 12-12-12 |
| **Pectoral fin** | R: X-X-X | |
| **Anal fin** | S: 3-3-3 | R: 15-X-16 |
| **Gill rakers** | U: X-X-X | L: 10-X-11 |

## MERISTICS — *Z. latipinnis* Girard 1857

| | | |
|---|---|---|
| **Vertebrae** | Total: 42-42-42 | |
| | Precaudal: 14-14-14 | |
| | Caudal: 28-28-28 | |
| **Branchiostegal rays** | 6-X-7 | |
| **Caudal fin** | 6-8, 7+6, 7-9 | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 5-5-5 |
| **Dorsal fin** | S: 21-X-22 | R: 11-X-12 |
| **Pectoral fin** | R: 14-14-14 | |
| **Anal fin** | S: 3-3-3 | R: 15-X-17 |
| **Gill rakers** | U: 3-3-3 | L: 8-X-9 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Brit. Col., 48°30′-55°N[a] |
| **Ecology** | Benthal[b] |
| **ELH pattern** | Oviparous, demersal eggs, pelagic larvae |
| **Spawning** | Season: Fall-winter (California)[c] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: 350-6530 (may produce three clutches/season)[c] |
| **Age at first maturity** | |
| **Longevity** | |

[a] *Z. frenata* only to Oregon, 42-46°N.
[b] *Z. frenata* epi- and mesobenthal (55-244 m); *Z. latipinnis* nearshore shelf (37-201 m).
[c] *Z. latipinnis* only (Goldberg 1980a).
[d] Data are from unfertilized, hydrated eggs of *Z. frenata* (W. Watson, Marine Ecological Consultants, 531 Encinitas Blvd., Suite 110, Encinitas, CA 92024, pers. commun., 6 Feb. 1988).

Ref: Kendall and Vinter 1984.

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.40-1.56 mm[d] |
| **No. of oil globules** | 30-50 (red, orange)[d] |
| **Oil globule diameter** | 0.04-0.12 mm[d] |
| **Yolk** | |
| **Envelope** | Finely striated[d] |
| **Hatch size** | 2.5 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

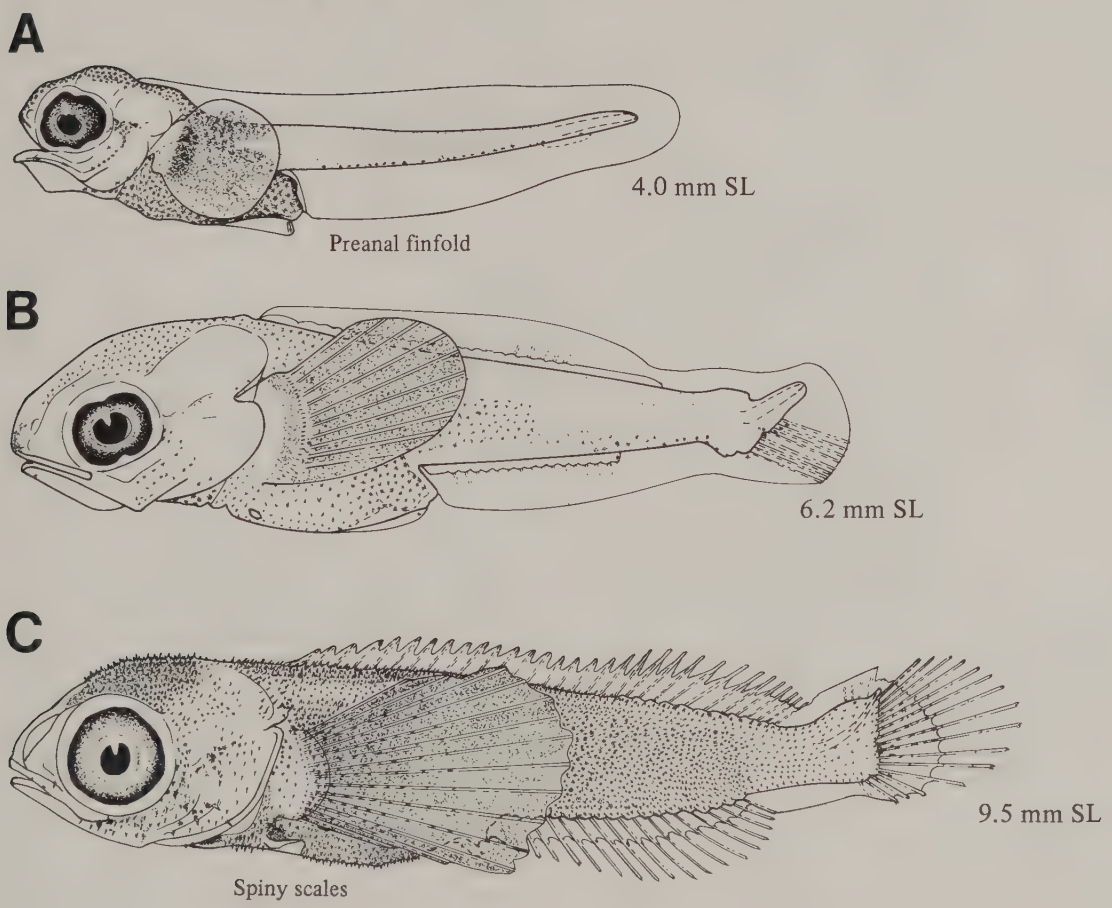
**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | ~50% SL |
| **Length at flexion** | 5-7 mm SL |
| **Length at transformation** | |
| **Sequence of fin development** | Pectorals, caudal, 2nd dorsal (rays) and anal, 1st dorsal (spines) and pelvics |

**Pigment**
- Laterally on gut
- Ventral midline
- Flexion larvae with increased pigment on body

**Diagnostic characters**
- See Table 33 for characters that allow separation from *Oxylebius pictus*
- Spiny scales




Figures A–C, Kendall and Vinter 1984.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 56-X-59 | |
| | Precaudal: 23-23-24 | |
| | Caudal: 33-34-35 | |
| **Branchiostegal rays** | 6-X-7 | |
| **Caudal fin** | 13-15, 7+7, 12-14 | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 5-5-5 |
| **Dorsal fin** | S: 25-X-28 | R: 19-X-21 |
| **Pectoral fin** | R: 16-X-18 | |
| **Anal fin** | S: 3-3-3 | R: 21-X-25 |
| **Gill rakers** | U: 5-X-8 | L: 16-X-19 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Gulf of Alaska, 54-60°N |
| **Ecology** | Epi- and mesobenthal, intertidal to 475 m |
| **ELH pattern** | Oviparous; demersal, adhesive, attached eggs; pelagic larvae |
| **Spawning** | Season: Dec-Apr[a]<br>Area: Intertidal to 19 m below low tide;[a] nest in rocky areas with high current velocities[b]<br>Mode: One or more nests guarded by male[c]<br>Migration: To shallow water[d] |
| **Fecundity** | Range/function: 60,000-500,000[e]/ $N=0.0002824\times L^{3.001}$ [f] |
| **Age at first maturity** | 2-3 yr[g] |
| **Longevity** | 20 yr[h] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 2.24-3.23 mm |
| **No. of oil globules** | One |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | Opaque, thick |
| **Hatch size** | 7-10 mm SL (9.3 mm SL) |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | ~43-55% SL |
| **Length at flexion** | 11-15 mm SL |
| **Length at transformation** | 30 mm SL; larvae remain pelagic to 52 mm SL |
| **Sequence of fin development** | Caudal and pectorals, 2nd dorsal (rays) and anal, 1st dorsal (spines), pelvics |

**Pigment**

- Head and snout
- Laterally on surface of gut
- Along dorsal midline and ventrolateral body
- Rather uniformly pigmented (flexion)

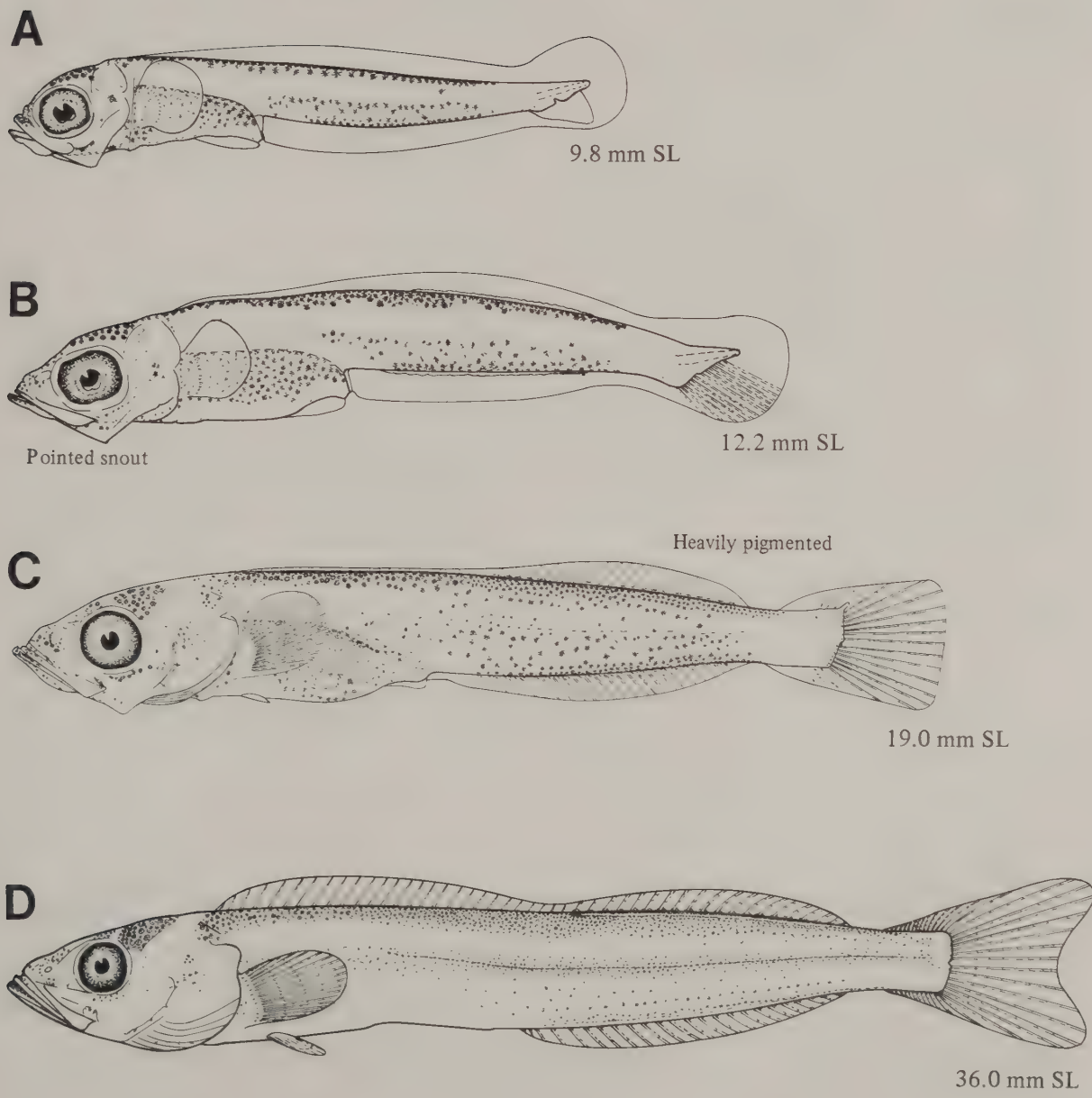
**Diagnostic characters** (see Table 3)

Distinguished from other hexagrammids by

- Pointed snout, protruding lower jaw
- Large terminal mouth with gape directed upward
- Longer gut
- Distribution of pigment on tail

[a] LaRiviere et al. 1981
[b] Giorgi 1981
[c] Jewell 1968
[d] Miller and Geibel 1973
[e] Phillips 1959
[f] Hart 1967; N=egg number.
[g] Frey 1971
[h] Fitch and Lavenberg 1971

Ref: Kendall and Vinter 1984.




Figures A–D, Kendall and Vinter 1984.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 58-X-63 | |
| | Precaudal: 26-X-28 | |
| | Caudal: 32-X-35 | |
| **Branchiostegal rays** | 5-X-7 | |
| **Caudal fin** | 16-19, 8+11, 16-20 | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 5-5-5 |
| **Dorsal fin** | S: 21-X-24 | R: 24-X-30 |
| **Pectoral fin** | R: 23-X-28 | |
| **Anal fin** | R: 23-X-28 | |
| **Gill rakers** | U: 6-X-8 | L: 16-X-19 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Bering Sea, 54-66°N |
| **Ecology** | Epi- and mesobenthal, intertidal to 575 m |
| **ELH pattern** | Oviparous; demersal, attached eggs; pelagic larvae |
| **Spawning** | Season: June-Sept (Bering Sea)[a]<br>Area:<br>Mode: Nests guarded by males[b]<br>Migration: |
| **Fecundity** | Range/function: 3653-18,694;[c] 43,000[a] |
| **Age at first maturity** | 3-4 yr[a] |
| **Longevity** | 11 yr[a] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 2.5-2.8 mm |
| **No. of oil globules** | Many in group |
| **Oil globule diameter** | 1.38-1.40 mm |
| **Yolk** | |
| **Envelope** | Smooth |
| **Hatch size** | ~8 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 33-50% SL |
| **Length at flexion** | 14-19 mm SL |
| **Length at transformation** | |
| **Sequence of fin development** | Caudal, pectorals, dorsal and anal, pelvics |

**Pigment**

- Midbrain and internally on hindbrain
- Dorsolateral surface of gut
- Postanal: Dorsal midline along body length to last myomere; ventral midline extends only from mid-body to last myomere
- Internal above and below notochord

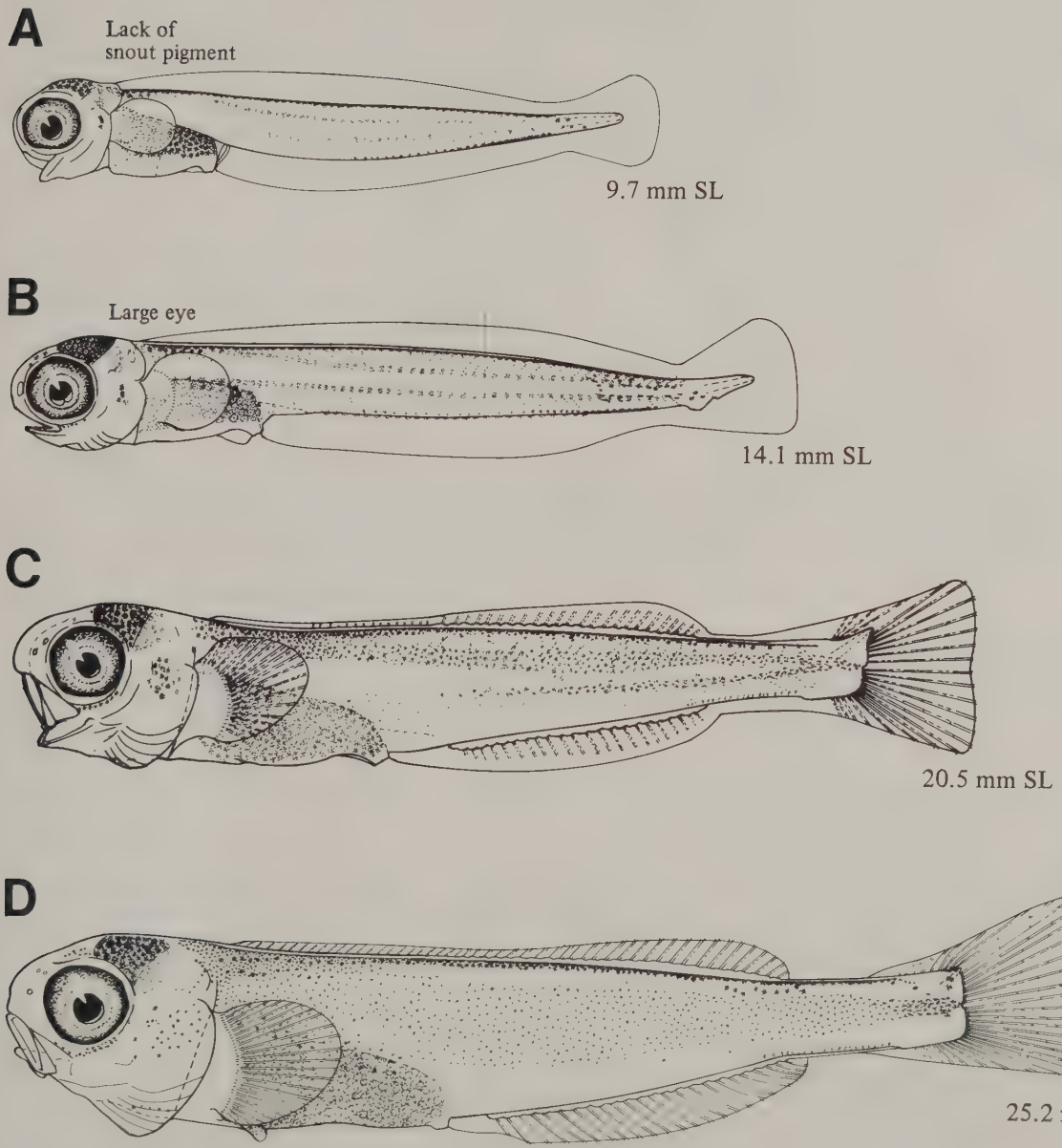
**Diagnostic characters** (see Table 3)

Distinguished from other hexagrammids by

- Pigment pattern (unpigmented snout)
- Morphology: Larger eye, shorter snout

[a] Gorbunova 1962
[b] Kendall and Vinter 1984
[c] Lee 1985

Ref: Kendall and Vinter 1984.




Figures A–D, Kendall and Vinter 1984.

## Table 34

**Guide for identifying Northeast Pacific species of *Hexagrammos* based on meristic characters (Kendall and Vinter 1984).**

| | | |
|---|---|---|
| **Based on principal ventral caudal fin rays*** | | |
| Principal ventral caudal rays | 8 | |
| precaudal vertebrae | 20-22 | = *H. stelleri* |
| precaudal vertebrae | 18-19 | = *H. octogrammus* |
| Principal ventral caudal rays | 9 | = *H. decagrammus* |
| Principal ventral caudal rays | 10 | = *H. lagocephalus* |
| **Based on extremes of meristic characters** | | |
| Dorsal fin spinous rays | 18-19 | = *H. octogrammus* |
| | 20-23 | = indeterminate |
| | 24-25 | = *H. stelleri* |
| Dorsal fin soft rays | 18-19 | = *H. stelleri* |
| | 20-25 | = indeterminate |
| | 26 | = *H. decagrammus* |
| Total anal fin elements | 21 | = *H. lagocephalus* |
| | 22-26 | = indeterminate |
| Precaudal vertebrae | 18-19 | = *H. octogrammus* |
| | 20-23 | = indeterminate |
| Caudal vertebrae | 31 | = *H. stelleri* |
| | 32-35 | = indeterminate |
| Total vertebrae | 50 | = *H. octogrammus* |
| | 51-57 | = indeterminate |

*Prior to completion of caudal fin development, the principal ventral caudal fin ray count can be one less in larvae.

## Table 35

**Pigmentation characteristics that distinguish larvae <30 mm of the four species of *Hexagrammos* in the Northeast Pacific (Kendall and Vinter 1984, in part).[a]**

| | Pigment area | | | |
|---|---|---|---|---|
| Species | Postanal ventral midline | Isthmus | Notochord tip | Internal pectoral fin base[b] (>17 mm) |
| *H. stelleri* | Absent until ~15 mm, then starts to form posteriorly (on caudal peduncle), later (>23 mm) forms along entire base of anal fin. | Absent at hatching. Anterior half gradually becomes pigmented starting at 10 mm. | Absent | Present |
| *H. decagrammus* | Absent until ~13 mm, then starts to form along anal fin base near its origin. By 18 mm along anal fin base to caudal peduncle. Spots more numerous and smaller than on *H. lagocephalus*. | About four equal-sized and -spaced spots form on each side making a "V." Present from ~9 mm on. | Absent at hatching but forms by ~10 mm. | Inconsistently present |
| *H. lagocephalus* | Present throughout development. Particularly dense on caudal peduncle. Spots along anal fin base tend not to touch each other. Spots uneven in spacing and size to create irregular line. Few spots anterior to origin of anal fin. | An anterior medial spot and about five equal-sized and -spaced spots present from ~9 mm on. | Present | Absent |
| *H. octogrammus* | Present throughout development. Extends from anus to base of caudal fin. Dense on caudal peduncle. Spots tend to touch each other to create a continuous straight line. | Present; anteriormost and posteriormost spots larger than others. Anterior medial spot seen at 10 mm, up to five on each side of isthmus seen at 12 mm. Spacing uneven. | Present | Present |

[a] Pigmentation characteristics discussed in this table were based on larvae collected in the Gulf of Alaska. Variation in some of these features is known to occur in larvae from other areas.

[b] One to a few spots occur near the dorsal edge of the internal surface of the pectoral fin base.

VENTRAL VIEW OF *HEXAGRAMMOS* SPP. LARVAE (16-18 mm SL)
DEPICTING PIGMENT ON THE LOWER JAW, ISTHMUS, AND POSTANAL VENTRAL MIDLINE

A *Hexagrammos stelleri*

B *Hexagrammos decagrammus*

C *Hexagrammos lagocephalus*

D *Hexagrammos octogrammus*

Figures A–D, Kendall and Vinter 1984.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 52-X-57 | |
| | Precaudal: 20-21-22 | |
| | Caudal: 33-X-35 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | 12-16, 7+9, 12-14 | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 5-5-5 |
| **Dorsal fin** | S: 21-X-23 | R: 22-X-26 |
| **Pectoral fin** | R: 18-X-20 | |
| **Anal fin** | R: 23-X-26 | |
| **Gill rakers** | U: 3-X-5 | L: 9-X-14 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Bering Sea, 54-66°N |
| **Ecology** | Intertidal, nearshore, 0-46 m |
| **ELH pattern** | Oviparous; demersal, attached eggs; pelagic larvae |
| **Spawning** | Season: Oct-Nov[a] |
| | Area: |
| | Mode: Egg masses on rocks[a] |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | 7-9 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | Much <50% before flexion |
| **Length at flexion** | 12-18 mm SL |
| **Length at transformation** | Epipelagic to 50 mm SL |
| **Sequence of fin development** | Caudal, pectorals, 2nd dorsal (rays) and anal, 1st dorsal (spines), pelvics |

**Pigment**

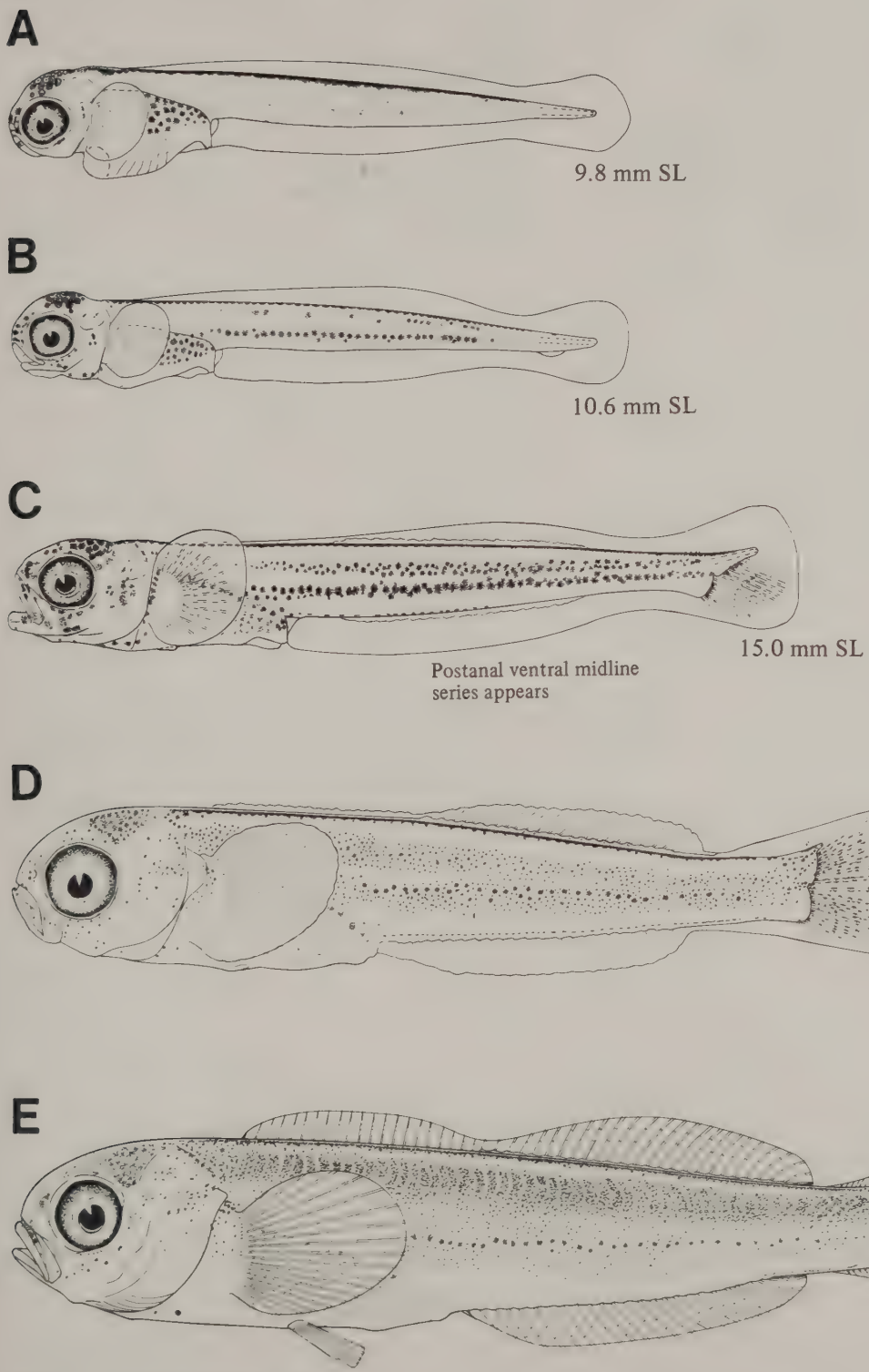
- Heavily pigmented
- Postanal ventral midline absent until ~13 mm SL, then starts near anal fin origin; reaches caudal peduncle by 18 mm SL

**Diagnostic characters** (see Table 3 and tables this section)

- Principal caudal fin ray count in juveniles (7+9)

[a] Marliave 1975a

Ref: Kendall and Vinter 1984.




Figures A–E, Kendall and Vinter 1984.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 52-X-57 | |
| | Precaudal: 20-20-23 | |
| | Caudal: 32-33-34 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | 17-22, 7+10, 15-19 | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 5-5-5 |
| **Dorsal fin** | S: 20-X-23 | R: 20-X-25 |
| **Pectoral fin** | R: 18-X-21 | |
| **Anal fin** | R: 21-X-24 | |
| **Gill rakers** | U: 4-X-5 | L: 9-X-11 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Cent. California, 34-38°N, to Bering Sea, 54-66°N |
| **Ecology** | Intertidal, nearshore |
| **ELH pattern** | Oviparous; demersal, adhesive, attached eggs; pelagic larvae |
| **Spawning** | Season: June-Aug (Aleutian Is.);[a] June-Sept (west. Pacific)[b] |
| | Area: On rocks or algal holdfasts in areas of strong currents[a] |
| | Mode: Intermittent, males guard nests[c] |
| | Migration: |
| **Fecundity** | Range/function: 14,400-103,000[b] |
| **Age at first maturity** | 3-4 yr[b] |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | 7-9 mm SL |
| **Incubation time/temp.** | 30 d/6-10°C |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | Much <50% before flexion |
| **Length at flexion** | ~16 mm SL |
| **Length at transformation** | |
| **Sequence of fin development** | Caudal, pectorals, 2nd dorsal (rays) and anal, 1st dorsal (spines), pelvics |

**Pigment**

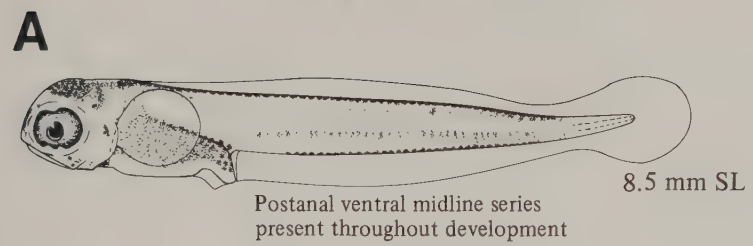
- Heavily pigmented
- Postanal ventral midline present throughout development, particularly heavy on caudal peduncle; spots create irregular line

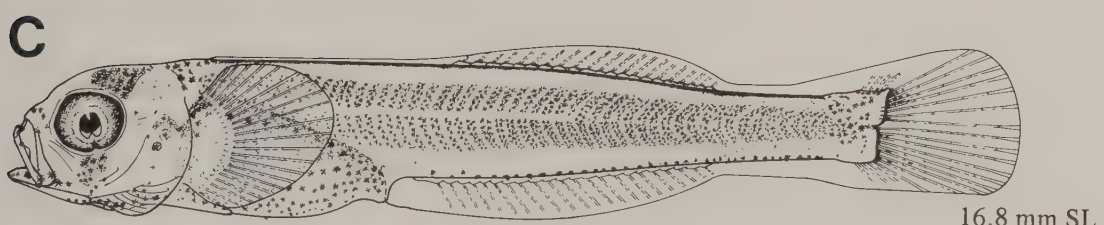
**Diagnostic characters** (see Table 3 and tables this section)

- Principal caudal fin ray count in juveniles (7+10)

[a] Simenstad 1971
[b] Gorbunova 1962
[c] Kendall and Vinter 1984

Ref: Kendall and Vinter 1984.





Figures A–D, Kendall and Vinter 1984.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 50-X-54 | |
| | Precaudal: 18-X-19 | |
| | Caudal: 32-X-35 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | 15-17, 7+8, 14-15 | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 5-5-5 |
| **Dorsal fin** | S: 18-X-20 | R: 22-X-25 |
| **Pectoral fin** | R: 18-X-19 | |
| **Anal fin** | R: 23-X-26 | |
| **Gill rakers** | U: 4-X-5 | L: 11-X-12 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Brit. Col., 48°30′-55°N, to Bering Sea, 54-66°N |
| **Ecology** | Nearshore shelf demersal |
| **ELH pattern** | Oviparous; demersal, attached eggs; pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: Nests guarded by males[a] |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS[b]

| | |
|---|---|
| **Diameter** | 1.75-2.10 mm |
| **No. of oil globules** | Many |
| **Oil globule diameter** | 0.8 mm |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | 7-9 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | Much <50% before flexion |
| **Length at flexion** | ~16 mm SL |
| **Length at transformation** | |
| **Sequence of fin development** | Caudal, pectorals, 2nd dorsal (rays) and anal, 1st dorsal (spines), pelvics |

**Pigment**

- Most heavily pigmented *Hexagrammos* sp.
- Postanal ventral midline present throughout development, forms continuous line from anus to base of caudal fin

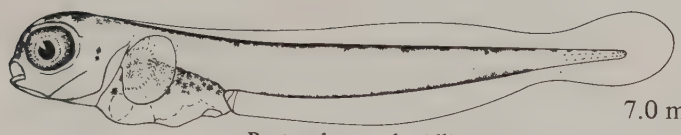
**Diagnostic characters** (see Table 3 and tables this section)

- Principal caudal fin ray count in juveniles (7+8)

[a] Kendall and Vinter 1984
[b] Data are from Gorbunova (1962) as cited in Washington et al. (1984b).

Ref: Kendall and Vinter 1984.

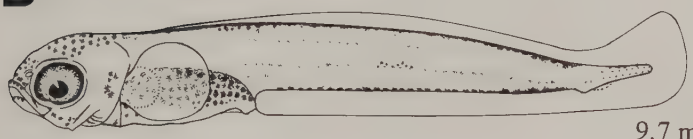
A



7.0 mm SL

Postanal ventral midline series
present throughout development

B



9.7 mm SL

C

15.2 mm SL

D

20.0 mm SL

E

27.8 mm SL

Figures A–E, Kendall and Vinter 1984.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 51-X-56 | |
| | Precaudal: 20-X-22 | |
| | Caudal: 31-X-34 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | 16-17, 7+8, 14-15 | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 5-5-5 |
| **Dorsal fin** | S: 22-X-25 | R: 18-X-22 |
| **Pectoral fin** | R: 18-X-20 | |
| **Anal fin** | R: 22-X-25 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Oregon, 42-46°N, to Chukchi Sea, north of 66°N |
| **Ecology** | Nearshore shelf demersal, intertidal to 175 m |
| **ELH pattern** | Oviparous; demersal, attached eggs; pelagic larvae |
| **Spawning** | Season: Feb[a] or Apr[b] (British Columbia); reported summer to fall at extremes of range in Pacific Ocean[c] |
| | Area: |
| | Mode: May be deposited on rocks[a] |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | 7-9 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | Much <50% before flexion |
| **Length at flexion** | ~15 mm SL |
| **Length at transformation** | |
| **Sequence of fin development** | Caudal, pectorals, 2nd dorsal (rays) and anal, 1st dorsal (spines), pelvics |

**Pigment**

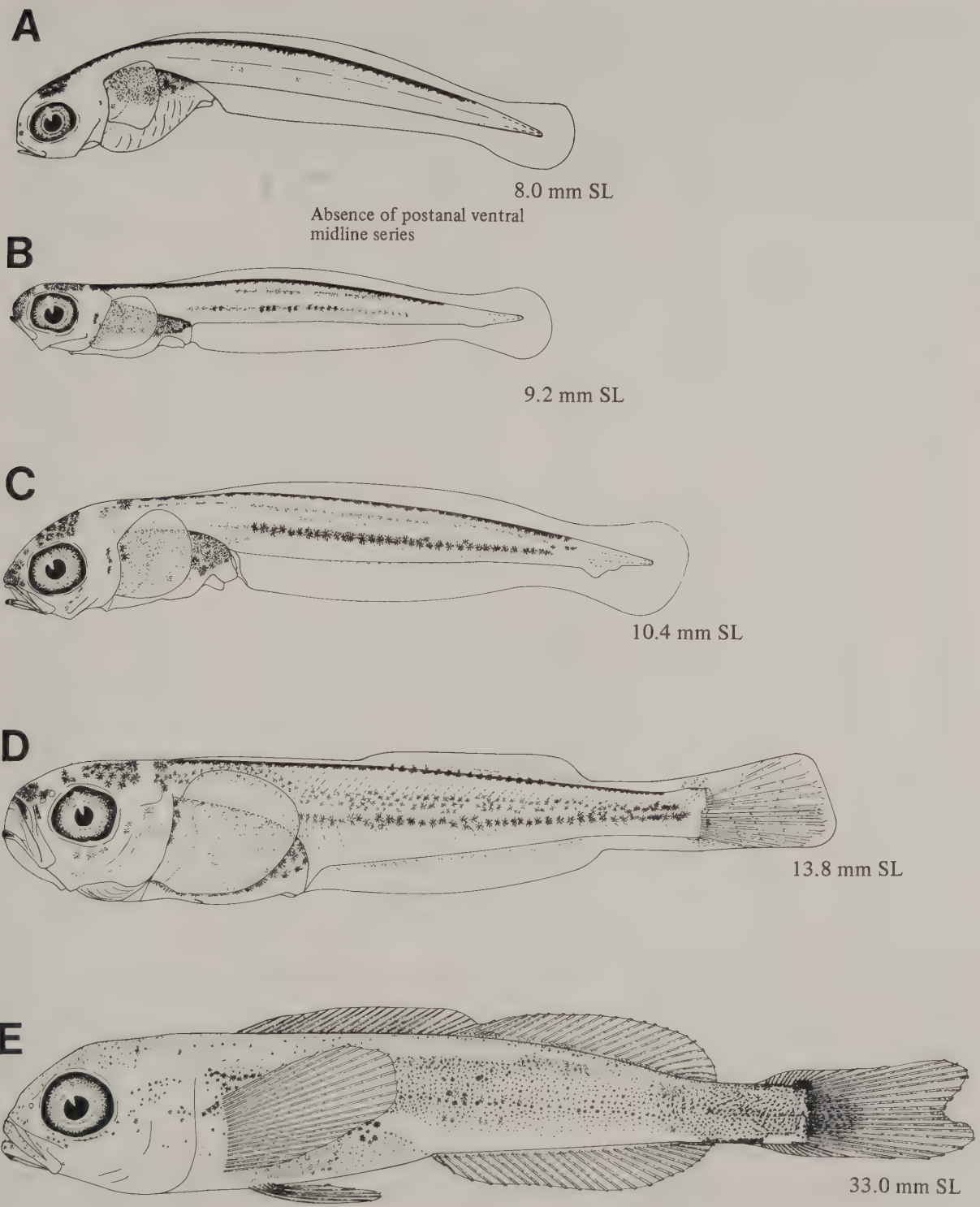
- Most lightly pigmented *Hexagrammos* sp.
- Postanal ventral midline absent until ~15 mm SL, then starts on caudal peduncle; by ~23 mm SL all along anal fin base

**Diagnostic characters** (see Table 3 and tables this section)

- Principal caudal fin ray count in juveniles (7+8)

[a] Clemens and Wilby 1961
[b] Hart 1973
[c] Gorbunova 1962

Ref: Kendall and Vinter 1984.




Figures A–E, Kendall and Vinter 1984.

# COTTIDAE

The sculpins are represented by over 100 species within 45 genera in the study area. Most species are benthic as juveniles and adults and planktonic as larvae. Adults commonly occur in nearshore and intertidal regions throughout the study area. Cottids generally produce demersal eggs that are guarded in shallow water. Although larval cottids are commonly collected during ichthyoplankton surveys, the early life histories of most species are poorly known and larval descriptions are available for fewer than half the species. The cottid section is arranged according to the phenetic groups first described by Richardson (1981a) and recently updated by Washington et al. (1984a).[1] Preceding the taxonomic sections, the groups are briefly described, representative taxa from each group are illustrated, and a table of meristic characters is provided (Table 36). Betsy Washington provided vertebral counts for several genera based on her osteological studies of the cottids.[2] In most cases (except for *Clinocottus acuticeps* where $n=3$), counts were taken from one specimen.

[1] Psychrolutidae (sensu J. Nelson 1984) is included within Cottidae.
[2] B.B. Washington, NMFS Natl. Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560, pers. commun., 8 Dec. 1986.

## Table 36

**Larval information, numbers of species, and meristic characters of genera of cottids from the Northeast Pacific Ocean. Counts are from Washington et al. (1984a) unless otherwise noted.**

| Genera | Larval[a] group | Number of species: Total[b] | Number of species: With larval descriptions | Vertebrae | Fins: Dorsal: Spines | Fins: Dorsal: Soft rays | Fins: Anal | Fins: Pectoral | Fins: Pelvic |
|---|---|---|---|---|---|---|---|---|---|
| *Archaulus* | | 1 | | | IX-X | 28-29 | 22-23 | 16 | I, 3 |
| *Artediellichthys* | | 1 | | | VII-IX | 12-13 | 9-11 | 21-23 | I, 3 |
| *Artediellisicus* | | 1 | | | | | | | |
| *Artediellus* | | 5 | | 28-30 | VI-IX | 11-14 | 10-14 | 20-24 | I, 3 |
| *Artedius* | Art[c] | 6 | 4 | 30-35 | VII-X | 14-18 | 10-14 | 13-17 | I, 2-3 |
| *Ascelichthys* | Myo | 1 | | 33-36 | VII-X | 17-19 | 13-16 | 16-18 | 0 |
| *Asemichthys* | | 1 | | 33-35 | IX-XI | 14-16 | 15-16 | 16-18 | I, 3 |
| *Blepsias* | Hem | 2 | 1 | 37-39 | VI-IX | 20-24 | 18-21 | 11-17 | I, 3 |
| *Chitonotus* | Myo | 1 | | 35-36 | VIII-XI | 14-17 | 14-17 | 16-18 | I, 2-3 |
| *Clinocottus* | Art | 4 | 4 | 31-34 | VII-X | 13-17 | 9-13 | 12-15 | I, 3 |
| *Cottus* | Lep | 2 | 1 | 34-39 | VII-XI | 16-21 | 12-18 | 13-17 | I, 4 |
| *Dasycottus* | Mal | 1 | | 34-35 | VIII-XI | 13-16 | 12-16 | 22-26 | I, 3 |
| *Enophrys* | Myo | 3 | 1 | 29-35 | VII-IX | 9-15 | 8-13 | 15-19 | I, 2-3 |
| *Eurymen* | | 1 | | 38 | VIII | 21-23 | 15-17 | 25-26 | I, 3 |
| *Gilbertidia*[d] | Psy | 1 | | 33-35 | VII-VIII | 18-19 | 12-15 | 14-17 | I, 3 |
| *Gymnocanthus* | Myo | 4 | 1-2 | 35-40 | IX-XII | 13-18 | 14-20 | 15-21 | I, 3 |
| *Hemilepidotus* | Hem-Sco | 6 | 5 | 35-39 | X-XII | 17-22 | 13-19 | 15-19 | I, 3-4 |
| *Hemitripterus* | Hem | 2 | 1 | 38-41 | XI-XIX | 11-14 | 12-15 | 18-22 | I, 3 |
| *Icelinus* | Myo | 5 | 1 | 34-39 | IX-XII | 14-18 | 11-17 | 14-19 | I, 2 |
| *Icelus* | Myo | 6 | | 37-42 | VII-X | 17-25 | 13-20 | 15-20 | I, 3 |
| *Jordania* | | 1 | | 46-48 | XVII-XVIII | 15-18 | 22-24 | 13-15 | I, 4-5 |
| *Leptocottus* | Lep | 1 | | 35-39 | VI-VIII | 15-20 | 15-20 | 17-20 | I, 4 |
| *Malacocottus* | Mal | 2-3 | 1 | 30-33 | VIII-X | 12-15 | 9-13 | 19-23 | I, 3 |
| *Megalocottus* | | 2 | | | VIII-X | 12-15 | 11-13 | 16-18 | I, 3 |
| *Microcottus* | | 1 | | 32-34 | VII-IX | 12-14 | 10-12 | 14-17 | I, 3 |
| *Myoxocephalus* | Myo | 9-10 | 1-2 | 34-46 | VIII-XII | 10-20 | 8-17 | 14-19 | I, 3 |
| *Nautichthys* | Hem | 3 | 1 | 35-41 | VII-X | 19-30 | 14-21 | 13-17 | I, 3 |
| *Oligocottus* | Art | 3 | 2 | 33-37 | VII-X | 15-20 | 12-15 | 12-15 | I, 3 |
| *Paricelinus* | Myo | 1 | | 42-43 | XII-XIII | 19-20 | 23-24 | 14-15 | I, 5 |
| *Phallocottus* | | 1 | | | X-XII | 22-24 | 22-25 | 14-16 | I, 3 |
| *Porocottus* | | 2 | | 34-38 | VIII-X | 13-18 | 11-18 | 13-19 | I, 3 |
| *Psychrolutes* | Psy | 2 | 1 | 33-37 | VIII-XII | 12-20 | 10-14 | 19-26 | I, 3 |
| *Radulinus* | Myo | 2 | 2 | 38-40 | VIII-XI | 20-23 | 21-25 | 17-20 | I, 3 |
| *Rhamphocottus* | Rha | 1 | | 26-28 | VII-IX | 12-14 | 6-9 | 14-18 | I, 3-4 |
| *Scorpaenichthys* | Hem-Sco | 1 | | 35-37 | VIII-XII | 15-19 | 11-14 | 14-16 | I, 4-5 |
| *Sigmistes* | | 2 | | 34-36 | VIII-X | 19-26 | 14-20 | 13-15 | I, 3 |
| *Stelgistrum* | | 2 | | 36 | VIII-IX | 17-19 | 12-14 | 14-16 | I, 3 |
| *Sternias* | | 1 | | 44-46 | X-XI | 22-24 | 22-24 | 16-18 | I, 3 |
| *Stlegicottus* | | 1 | | | IX | 19 | 17 | 18 | I, 3 |
| *Synchirus* | Myo | 1 | | 38-39 | VIII-X | 19-21 | 18-21 | 21-24 | I, 3 |
| *Taurocottus* | | 1 | | | XI | 15-16 | 12-13 | 19 | I, 3 |
| *Thecopterus* | | 1 | | | X | 14 | 11 | 20 | I, 2 |
| *Thyriscus* | | 1 | | 38-39 | X | 21 | 17 | 15 | I, 3 |
| *Triglops* | | 6 | 1? | 45-54 | IX-XIII | 21-32 | 20-32 | 15-22 | I, 3 |
| *Zesticelus* | Myo | 1 | | 25-26 | V-VII | 10-13 | 8-11 | 19-21 | I, 2-3 |

[a] Art - *Artedius*
Hem - *Hemitripterus*
Hem-Sco - *Hemilepidotus-Scorpaenichthys*
Lep - *Leptocottus*
Mal - *Malacocottus*
Myo - *Myoxocephalus*
Psy - *Psychrolutes*
Rha - *Rhamphocottus*

[b] Limited to study area.

[c] *Artedius meanyi* is placed in *Myoxocephalus* group.

[d] B.B. Washington, NMFS Natl. Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560, pers. commun., 8 Dec. 1986.

## PHENETIC GROUPS

***Rhamphocottus* (*Rhamphocottus*)** Larvae are extremely deep-bodied with a long snout-anus length. Melanophores develop uniformly over the body except on the caudal peduncle and ventral gut surface. Small prickles develop all over the body by 9-10 mm, and only one preopercular spine develops.

---

***Hemilepidotus-Scorpaenichthys* (*Hemilepidotus*, *Scorpaenichthys*)** Larvae are relatively long and slender at hatching with moderately long guts (40-60% SL) and rounded snouts. They become increasingly deep-bodied. Larvae are relatively heavily pigmented. Four prominent preopercular spines develop.

---

***Myoxocephalus* (*Artedius meanyi*, *Ascelichthys*, *Chitonotus*, *Enophrys*, *Gymnocanthus*, *Icelinus*, *Icelus*, *Myoxocephalus*, *Paricelinus*, *Radulinus*, *Synchirus*, *Triglops*)** Larvae are generally slender-bodied with pointed snouts. Pigment is variable, but most members have heavy pigment on dorsal surface of the gut, nape, and along the postanal ventral midline. Larvae develop four preopercular spines and a distinct bony preopercular shelf. Parietal, nuchal, supracleithral, posttemporal, and occasionally postocular spines develop.

---

***Artedius* (*Artedius* other than *A. meanyi*; *Clinocottus*, *Oligocottus*)** Larvae are stubby-bodied with a slightly humped appearance at the nape. Snouts are rounded and guts trail distinctively below the ventral body midline. Some species have gut diverticula. Pigment is relatively light, occurring on the nape, over the gut, and along the postanal ventral midline. Larvae develop a unique preopercular spine pattern with 6-24 spines (enlarged on illustrations).

PHENETIC GROUPS

RHAMPHOCOTTUS

A *Rhamphocottus richardsoni*

8.4 mm NL

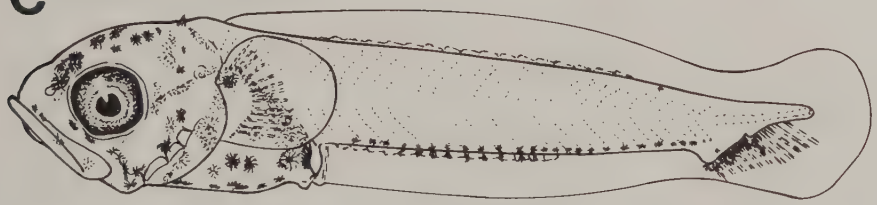
HEMILEPIDOTUS – SCORPAENICHTHYS

B *Hemilepidotus spinosus*

8.9 mm NL

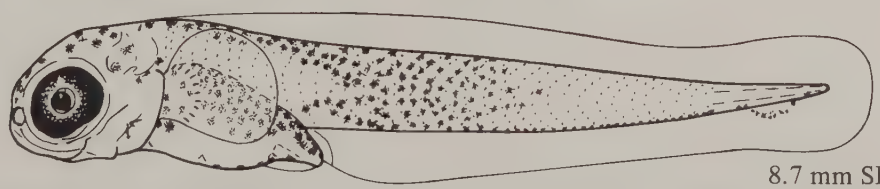
MYOXOCEPHALUS

C *Ascelichthys rhodorus*



9.0 mm SL

D *Myoxocephalus* G



8.7 mm SL

ARTEDIUS

E *Artedius harringtoni*

6.9 mm NL

Figures A–B, E, Richardson and Washington 1980; C, Matarese and Marliave 1982; D, NWAFC original (B. Vinter).

***Psychrolutes* (*Gilbertidia*, *Psychrolutes*)** Larvae are tadpole-shaped with large rounded heads tapering toward the tail. They possess an outer layer of flabby skin. The head, nape, gut, and pectoral fins are pigmented. No postanal ventral midline melanophores are present, but pigment is added laterally with development. Head and preopercular spines are absent.

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***Malacocottus* (*Dasycottus*, *Malacocottus*)** Similar to *Psychrolutes* group but larvae develop 4-5 preopercular spines.

---

***Leptocottus* (*Cottus*, *Leptocottus*)** Larvae are relatively slender with rounded snouts and moderately short guts. Pigment is light on the postanal body. Other pigment occurs on nape, over gut, and widely spaced along the postanal ventral midline. Four weak preopercular spines develop but other head spines are lacking.

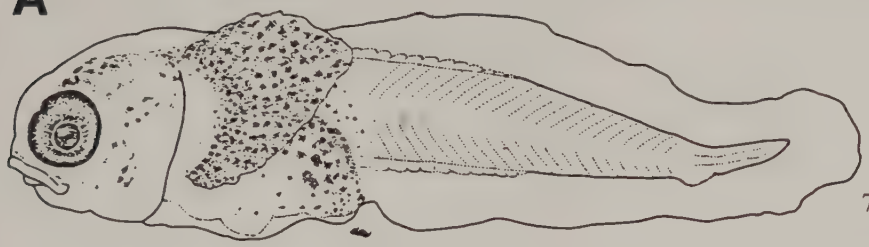
---

***Hemitripterus* (*Blepsias*, *Hemitripterus*, *Nautichthys*)** Newly hatched larvae are elongate and slender, becoming deeper with development. *Nautichthys* larvae have long pigmented pectoral fins. Pigmentation is heavy, covering the body except for the caudal peduncle. Pigment extends into the dorsal and ventral finfolds. Larvae develop four prominent preopercular spines.

PHENETIC GROUPS

*PSYCHROLUTES*

A *Psychrolutes paradoxus*



7.7 mm NL

*MALACOCOTTUS*

B *Malacocottus zonurus*

9.8 mm NL

*LEPTOCOTTUS*

C *Leptocottus armatus*

8.1 mm NL

*HEMITRIPTERUS*

D *Hemitripterus villosus*

14.4 mm SL

Figures A–B, Richardson and Bond 1980; C, Richardson and Washington 1980; D, Okiyama and Sando 1976.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 26-26-28 | |
| | Precaudal: 12-12-12[a] | |
| | Caudal: 15-15-15[a] | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 3-3-4 |
| **Dorsal fin** | S: 7-8-9 | R: 12-12-14 |
| **Pectoral fin** | R: 14-15-18 | |
| **Anal fin** | R: 6-7-9 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Bering Sea, 54-66°N |
| **Ecology** | Epi- and mesobenthal, intertidal to 274 m |
| **ELH pattern** | Oviparous, demersal eggs, pelagic larvae |
| **Spawning** | Season: Aug-Oct (California);[b] winter (British Columbia)[c] |
| | Area: Nearshore (20 m)[d] |
| | Mode: Egg masses guarded by females[d] |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 2.5-2.8 mm |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | Orange;[c] white[d] |
| **Hatch size** | 6-7 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | >50% SL |
| **Length at flexion** | 6.9-10.0 mm NL |
| **Length at transformation** | 14-15 mm SL |
| **Sequence of fin development** | Dorsal, anal, and pectorals followed by caudal and pelvics |

**Pigment**

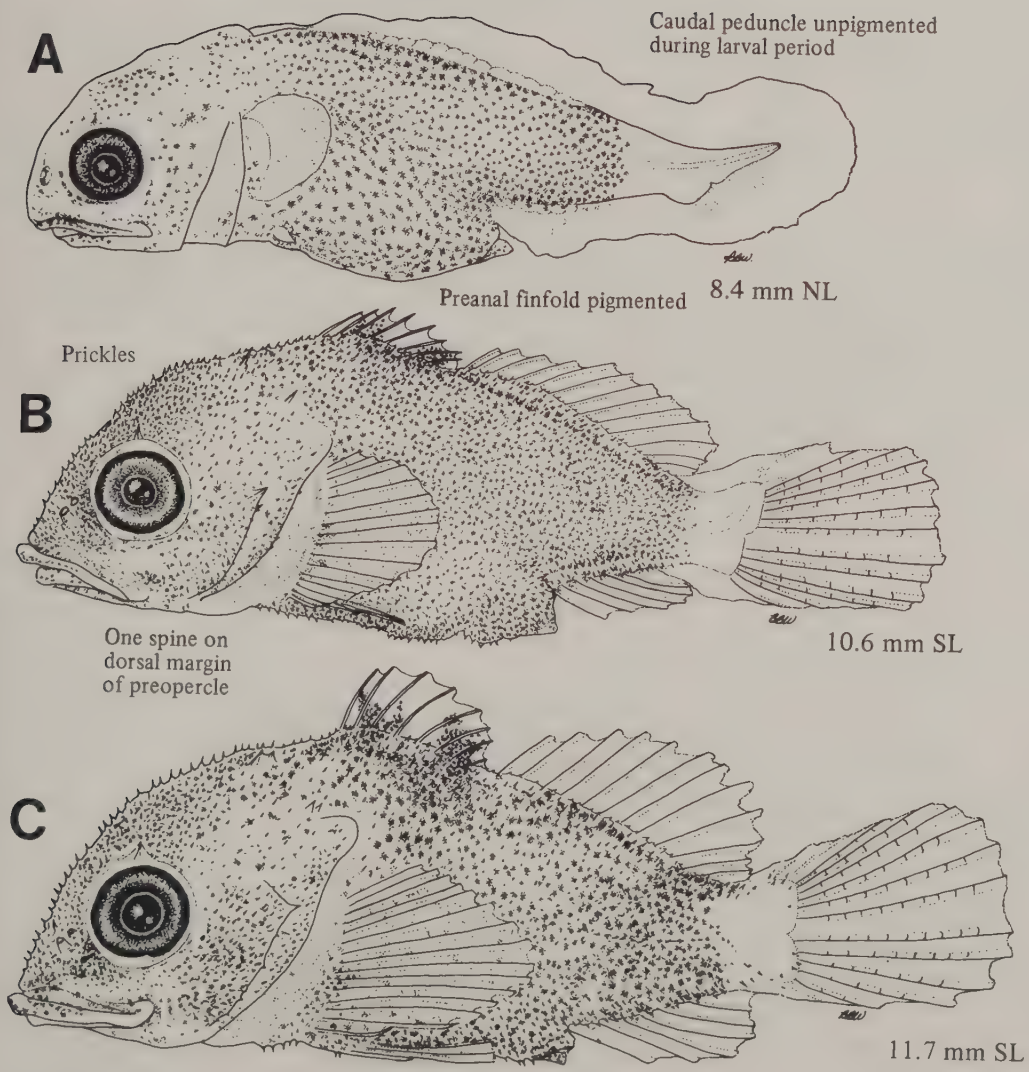
- Larvae are uniformly covered with melanophores except for caudal peduncle and the ventral surface of gut

**Diagnostic characters** (see Table 3)

- Morphology: Deep-bodied, very long snout-to-anus length
- Uniformily heavily pigmented
- Presence of pigmented preanal finfold
- Prickles develop over most of body by 9-10 mm SL
- Spines: Only one preopercular (small spiny projections appear along the preopercular margin); others include parietal, nuchal, supracleithral, posttemporal, and postocular

[a] B.B. Washington, NMFS Natl. Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560, unpubl.
[b] Fitch and Lavenberg 1975
[c] Hart 1973
[d] Garrison and Miller 1982

Ref: Blackburn 1973, Marliave 1975a, Richardson and Washington 1980, Saruwatari et al. 1987, Washington et al. 1984b.




Figures A–C, Richardson and Washington 1980.

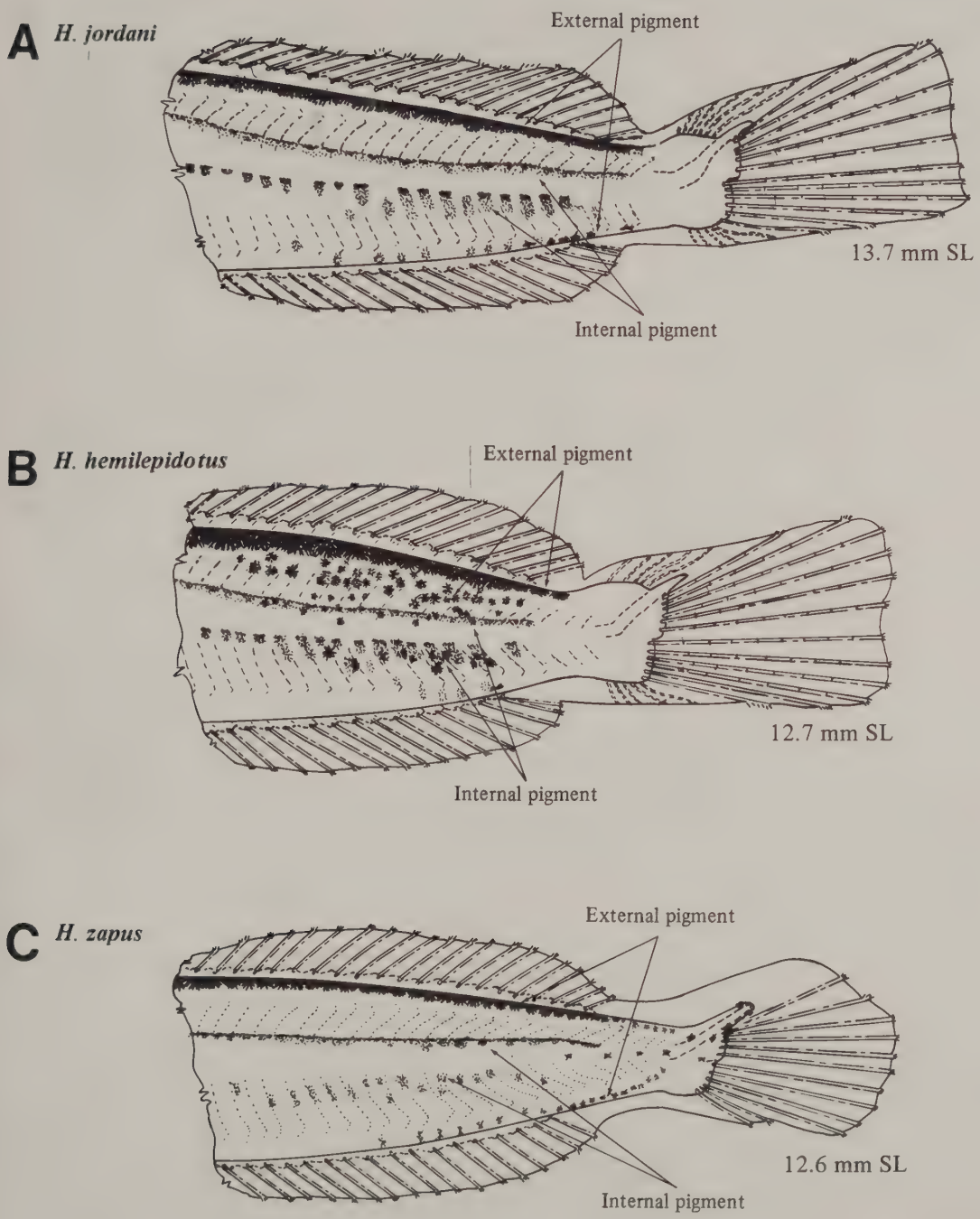
## Table 37

**Selected postanal pigmentation characters useful in distinguishing preflexion and flexion *Hemilepidotus* larvae (Matarese and Vinter 1985). Larvae of *H. papilio* are unknown. All lengths are mm SL.**

| | Pigmentation characters | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Taxon | Dorsal midline | Dorso-lateral | Above notochord (internal) | Below notochord (internal) | Ventro-lateral | Ventral midline | Caudal region | Diagnostic |
| *Hemilepidotus spinosus* | By 5 mm, a continuous line from head to posteriormost myomere, becoming heavier | By 6 mm, becoming heavier | By 8-9 mm, along length of body | Not obvious | By 6 mm, becoming heavier | From anus to posteriormost myomere, >15 melanophores | Sparse, ventral midline continuous | Lateral, ventral midline |
| *H. hemilepidotus* | Until 7 mm, unpigmented area between myomeres 4-11 becoming moderately heavy | By 11 mm, moderate | By 6-7 mm, along length of body | By 8-9 mm, begins posterior to anus | By 11 mm, moderate | Begins 9 myomeres after anus, <15 melanophores | None | Lateral, lack of caudal pigment |
| *H. jordani*[a] | Similar to *H. hemilepidotus* but not as heavy | None | Similar to *H. hemilepidotus* | Similar to *H. hemilepidotus* | Some internal only | By flexion, a few internal melanophores | None | Lack of lateral and caudal pigment |
| *H. zapus* | Similar to *H. hemilepidotus* but not as heavy | None | By 6 mm, along length of body | By 8 mm, incomplete; begins posterior to anus | Some internal only | Begins 11 myomeres after anus, <15 melanophores | Ventral midline continuous, above and below urostyle | Urostyle |
| *H. gilberti*[b] | Pigment begins 8-9 myomeres after anus | None | None | None | None | Begins 10 myomeres after anus, <15 melanophores | None | Unpigmented area along dorsal midline, lack of lateral pigment |

[a] Preflexion larvae of *H. hemilepidotus* and *H. jordani* cannot presently be separated in samples from areas where they co-occur.
[b] Specimens were not available; description based on figures in Hattori (1964).

## POSTANAL PIGMENT PATTERNS OF *HEMILEPIDOTUS* SPP. LARVAE




Figures A–C, Matarese and Vinter 1985.

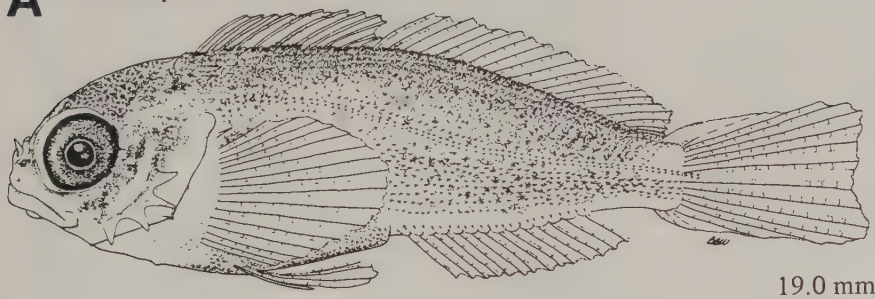
**Table 38**

**Characters useful in distinguishing pelagic juveniles of *Hemilepidotus* spp. (Peden 1978, in part). Specimens of *H. papilio* and *H. gilberti* have not been collected from the study area and are not included here.**

| Character | *H. hemilepidotus* | *H. jordani* | *H. spinosus* | *H. zapus* |
|---|---|---|---|---|
| Pectoral fin rays | 16(15-17) | 18(17-19) | 15-16(14-16) | 16(15-17) |
| Total soft fin rays; dorsal, anal, and both pectoral fins | 63-68 | 71-78 | 63-66 | 67-76 |
| Lateral line pores | 65(59-68) | 64(59-68) | 63(57-67) | 52(47-58) |
| Vertebrae | 35-37 | 37-39 | 36 | 37-38 |
| Horizontal rows in ventral scale band | 6 or 7 | ~8 | ~4 | 8 or 9 |
| Gill membranes fused to isthmus so as to form a free fold posteriorly | Yes | Yes | No free fold posteriorly | Yes |
| Horizontal rows in dorsal scale band | ≤5 | ≤5 | ≥6 | ≤5 |

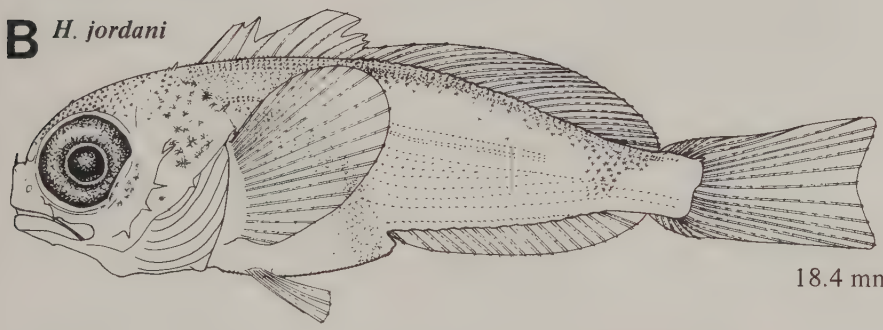
## PELAGIC JUVENILES

A *H. hemilepidotus*



19.0 mm SL

B *H. jordani*

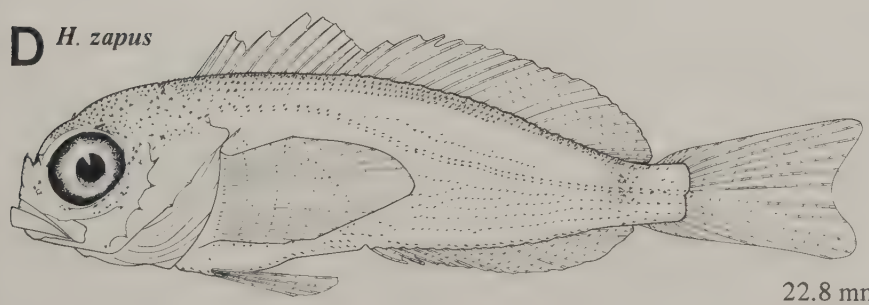


18.4 mm SL

C *H. spinosus*

19.0 mm SL

D *H. zapus*



22.8 mm SL

Figure A, C, Richardson and Washington 1980; B, NWAFC original (B. Vinter); D, Matarese and Vinter 1985.

# *Hemilepidotus gilberti*
# Jordan and Starks 1904

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 36-X-38 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 4-4-4 |
| **Dorsal fin** | S: 11-X-12 | R: 17-X-22 |
| **Pectoral fin** | R: 15-X-17 | |
| **Anal fin** | R: 14-X-19 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Bering Sea, 54-66°N |
| **Ecology** | Nearshore shelf demersal |
| **ELH pattern** | Oviparous, eggs probably demersal, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL increasing with development to 50% SL |
| **Length at flexion** | ~7-12 mm SL |
| **Length at transformation** | |
| **Sequence of fin development** | |

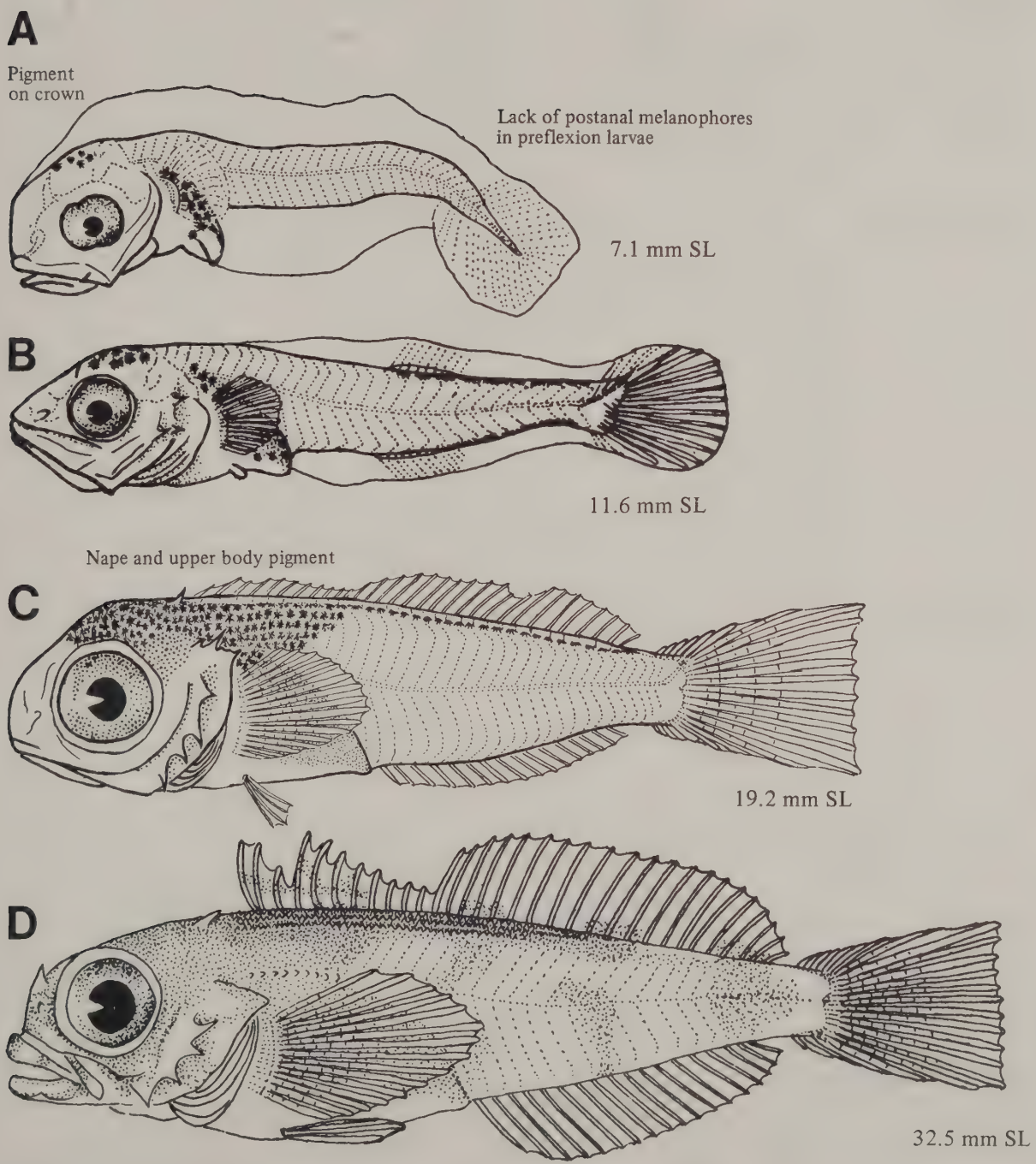
**Pigment**

- Head and dorsal gut
- With development, nape, upper body, and along dorsal midline

**Diagnostic characters** (see Tables 3 and 37)

- Unpigmented area along dorsal midline in preflexion larvae
- Lack of lateral pigment throughout larval period

Ref: Hattori 1964, Matarese and Vinter 1985.




Figures A–D, Hattori 1964. Identification of Figure B is questionable as only 30 myomeres are illustrated.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 35-36-37 | |
| | Precaudal: 12-12-12[a] | |
| | Caudal: 24-24-24[a] | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 3-4-4 |
| **Dorsal fin** | S: 10-11-13 | R: 18-19-20 |
| **Pectoral fin** | R: 15-16-17 | |
| **Anal fin** | R: 13-15-16 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Cent. California, 34-38°N, to Bering Sea, 54-66°N |
| **Ecology** | Epi- and mesobenthal, intertidal to 275 m |
| **ELH pattern** | Oviparous; demersal, adhesive, guarded eggs; pelagic larvae |
| **Spawning** | Season: Oct-Jan[b]<br>Area: Shallow water on rocks or pilings in areas with high current velocities[b]<br>Mode: Guarded by female, male, or both[b]<br>Migration: |
| **Fecundity** | Range/function: 59,000-126,000[b] |
| **Age at first maturity** | 4 yr[b] |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.5-1.6 mm |
| **No. of oil globules** | One |
| **Oil globule diameter** | 0.31-0.56 mm |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | 5-6 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 34% SL increasing with development to >50% SL |
| **Length at flexion** | <9 mm SL |
| **Length at transformation** | >19-23 mm SL |
| **Sequence of fin development** | |

**Pigment**

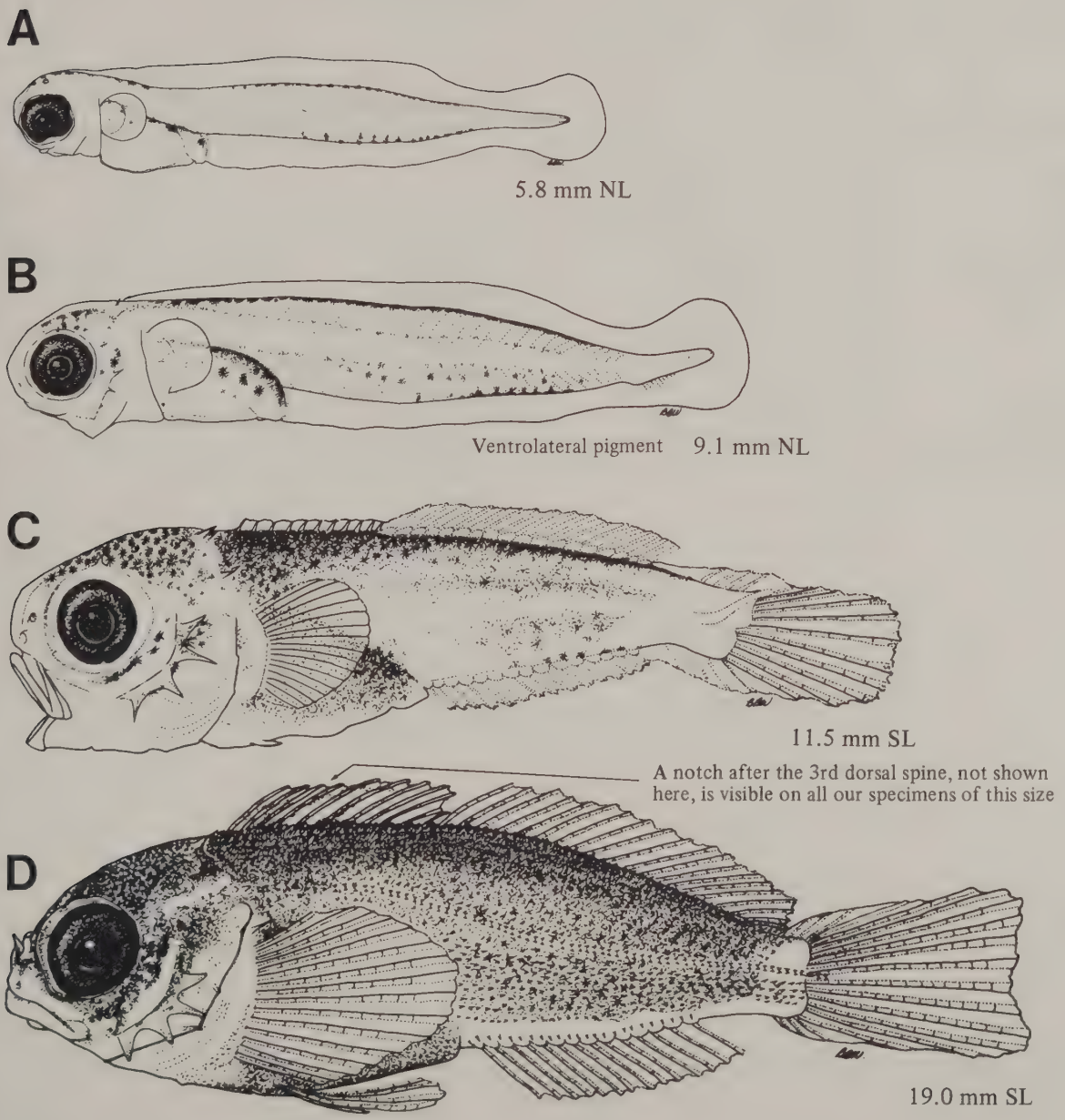
- Dorsal pigment on head and gut
- Break in dorsal midline pigment above gut (preflexion)
- Short posteriorly placed ventral midline series
- Lateral pigment on postanal body

**Diagnostic characters** (see Tables 3 and 37-38)

- Pigment
  - —Lack of pigment around urostyle
  - —Presence of dorso- and ventrolateral pigment

[a] B.B. Washington, NMFS Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560, unpubl.
[b] Garrison and Miller 1982

Ref: Richardson and Washington 1980, Washington et al. 1984b.


A
5.8 mm NL
B
Ventrolateral pigment 9.1 mm NL
C
11.5 mm SL
A notch after the 3rd dorsal spine, not shown here, is visible on all our specimens of this size
D
19.0 mm SL

Figures A–D, Richardson and Washington 1980.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 37-38-39 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 3-4-4 |
| **Dorsal fin** | S: 10-11-12 | R: 17-21-22 |
| **Pectoral fin** | R: 17-18-19 | |
| **Anal fin** | R: 16-17-18 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | SE Alaska, 55-59°N, to Bering Sea, 54-66°N |
| **Ecology** | Epi- and mesobenthal, 25-525 m |
| **ELH pattern** | Oviparous, eggs probably demersal, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE[a]

**Preanal length**
**Length at flexion**
**Length at transformation**
**Sequence of fin development**
**Pigment**

- Similar to *H. hemilepidotus* except generally less pigmented (see p. 374)
- Ventrolateral pigment internal only

**Diagnostic characters** (see Tables 3 and 37-38)

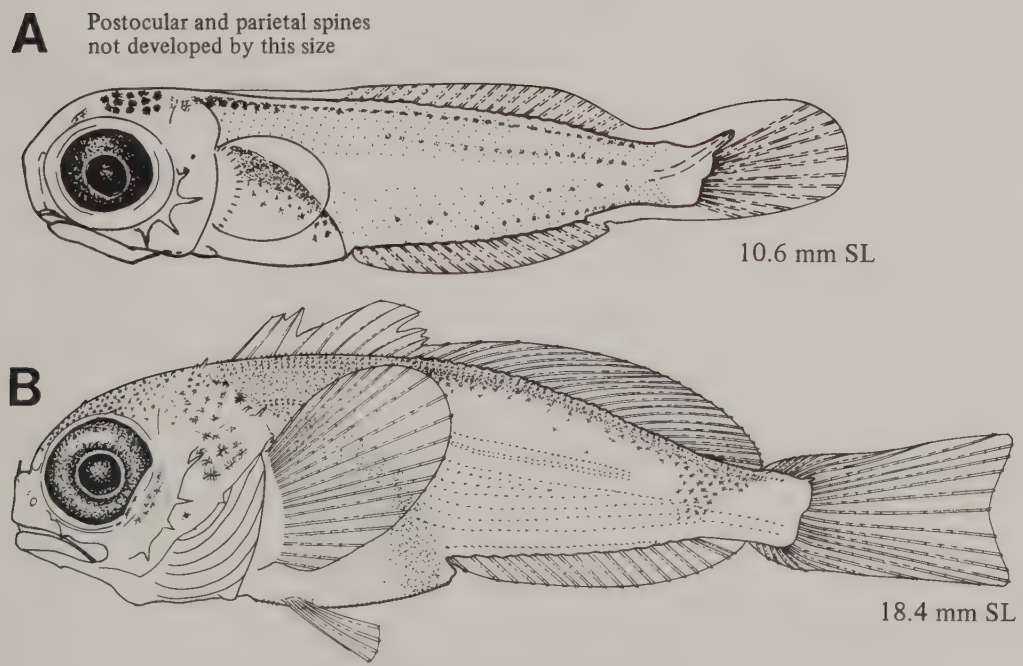
- Lack of lateral and caudal pigment

Distinguished from *H. hemilepidotus* postflexion larvae by

- Less dorso- and ventrolateral pigment (see figure, p. 371)
- Delayed development of postocular and parietal spines

[a] Preflexion larvae of *H. hemilepidotus* and *H. jordani* cannot presently be separated in samples from areas where they co-occur.

Ref: Matarese and Vinter 1985.




Figures A–B, NWAFC originals (B. Vinter).

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 35-36-37 | |
| | Precaudal: 12-12-12 | |
| | Caudal: 23-24-25 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 4-4-4 |
| **Dorsal fin** | S: 10-11-11 | R: 18-20-20 |
| **Pectoral fin** | R: 14-15-16 | |
| **Anal fin** | R: 14-15-16 | |
| **Gill rakers** | U: 2-2-2 | L: 5-X-8 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to SE Alaska, 55-59°N |
| **Ecology** | Nearshore shelf demersal, intertidal to 97 m |
| **ELH pattern** | Oviparous, eggs probably demersal, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | ~5 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 38% SL increasing with development to >50% SL |
| **Length at flexion** | 7.6-10.0 mm SL |
| **Length at transformation** | 19 mm SL |
| **Sequence of fin development** | |

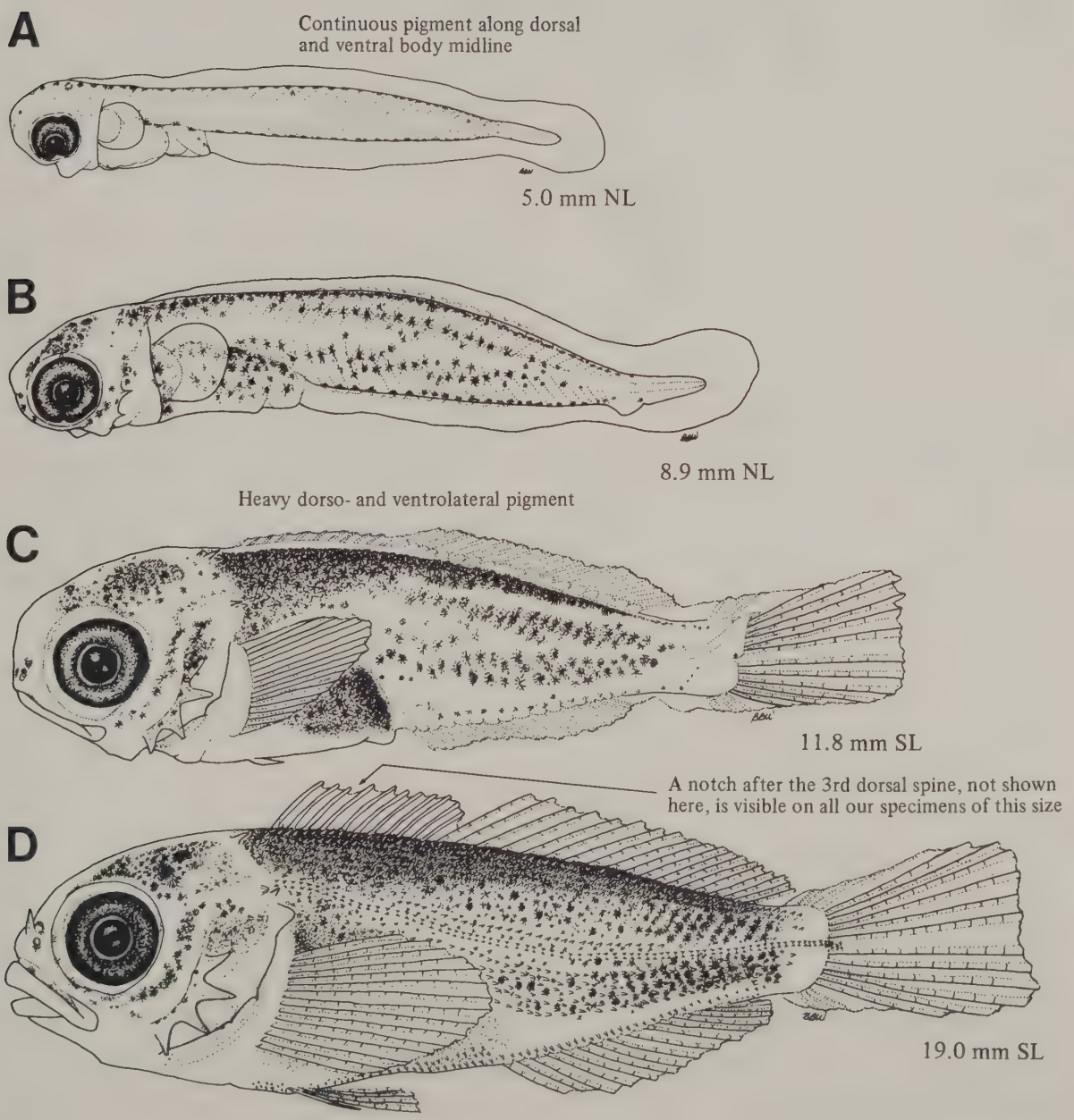
**Pigment**

- Dorso- and ventrolateral at 6 mm SL becoming heavier with development
- Preflexion larvae (>5 mm SL) have continuous line of dorsal midline pigment extending from head to posteriormost myomere

**Diagnostic characters** (see Tables 3 and 37-38)

- Pigment: Lateral, ventral midline
- Preflexion: Continuous pigment along dorsal and ventral body midline
- Flexion and larger: Heavy concentration of lateral pigment

Ref: Richardson and Washington 1980, Washington et al. 1984b.


A
Continuous pigment along dorsal and ventral body midline
5.0 mm NL
B
8.9 mm NL
Heavy dorso- and ventrolateral pigment
C
11.8 mm SL
A notch after the 3rd dorsal spine, not shown here, is visible on all our specimens of this size
D
19.0 mm SL

Figures A–D, Richardson and Washington 1980.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 37-38-38 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | X, 6+6, X | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 4-4-4 |
| **Dorsal fin** | S: 11-11-12 | R: 18-20-22 |
| **Pectoral fin** | R: 15-15-17 | |
| **Anal fin** | R: 16-17-17 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Aleutian Is., 51-55°N, to Chukchi Sea, north of 66°N |
| **Ecology** | Nearshore shelf demersal |
| **ELH pattern** | Oviparous, eggs probably demersal, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | ~4.3 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | Complete at 13 mm SL |
| **Length at transformation** | >22.8 mm SL |
| **Sequence of fin development** | |

**Pigment**

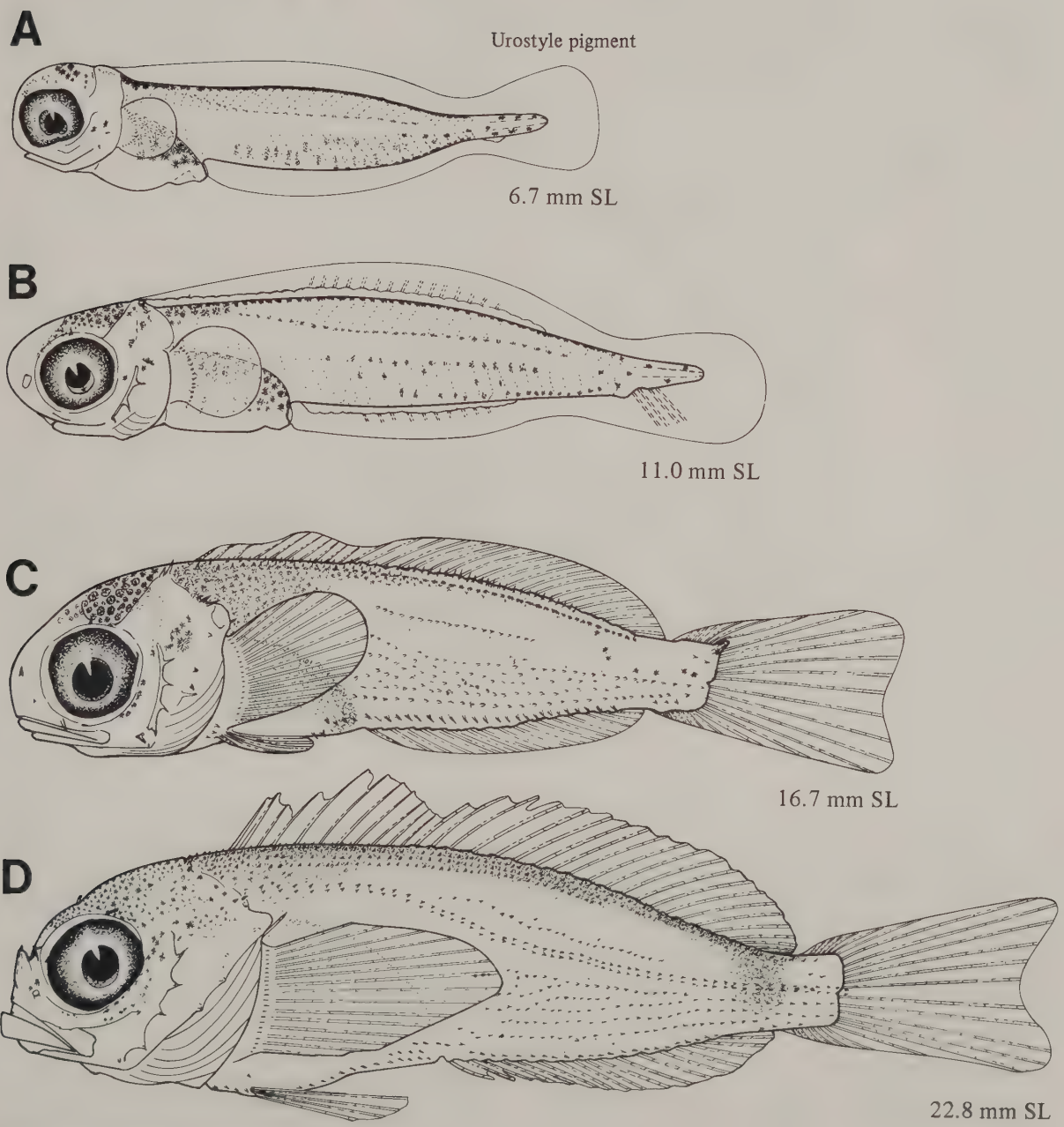
- Similar to *H. hemilepidotus* except generally less pigmented (see p. 374)
- Preflexion larvae have pigment above and below urostyle

**Diagnostic characters** (see Tables 3 and 37-38)

- Pigment above and below urostyle

See also pelagic juvenile figure of *H. hemilepidotus* and *H. jordani* (p. 371)

Ref: Gorbunova 1964, Matarese and Vinter 1985.




Figures A–D, Matarese and Vinter 1985.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 35-36-37 | |
| | Precaudal: 13-15-16 | |
| | Caudal: 20-21-23 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 4-5-5 |
| **Dorsal fin** | S: 8-11-12 | R: 15-18-19 |
| **Pectoral fin** | R: 14-15-16 | |
| **Anal fin** | R: 11-13-14 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to SE Alaska, 55-59°N |
| **Ecology** | Nearshore shelf demersal, intertidal to 76 m |
| **ELH pattern** | Oviparous; demersal, adhesive, attached eggs; pelagic larvae |
| **Spawning** | Season: Nov-Mar (California);[a] Jan-May (British Columbia)[b]<br>Area: In rocky crevices[c] or on algae[d]<br>Mode:<br>Migration: |
| **Fecundity** | Range/function: 49,000-98,000 (may spawn twice in one season)[a] |
| **Age at first maturity** | 3-4 yr (females)[a]<br>2-3 yr (males)[a] |
| **Longevity** | 13 yr[a] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.4-1.9 mm |
| **No. of oil globules** | One large with 1-4 smaller ones |
| **Oil globule diameter** | 0.2-0.3 mm[e] |
| **Yolk** | Homogeneous |
| **Envelope** | Thick, translucent |
| **Hatch size** | 4-6 mm SL;[f] 3.1-4.8 mm SL[e] (yolk absorbed by 6.5 mm SL) |
| **Incubation time/temp.** | |
| **Pigment** | |
| **Diagnostic characters** | |

### LARVAE

| | |
|---|---|
| **Preanal length** | 45-50% SL |
| **Length at flexion** | ~7.5-8.7 mm SL |
| **Length at transformation** | 14 mm SL, but remains pelagic until 35 mm SL |
| **Sequence of fin development** | |

**Pigment**

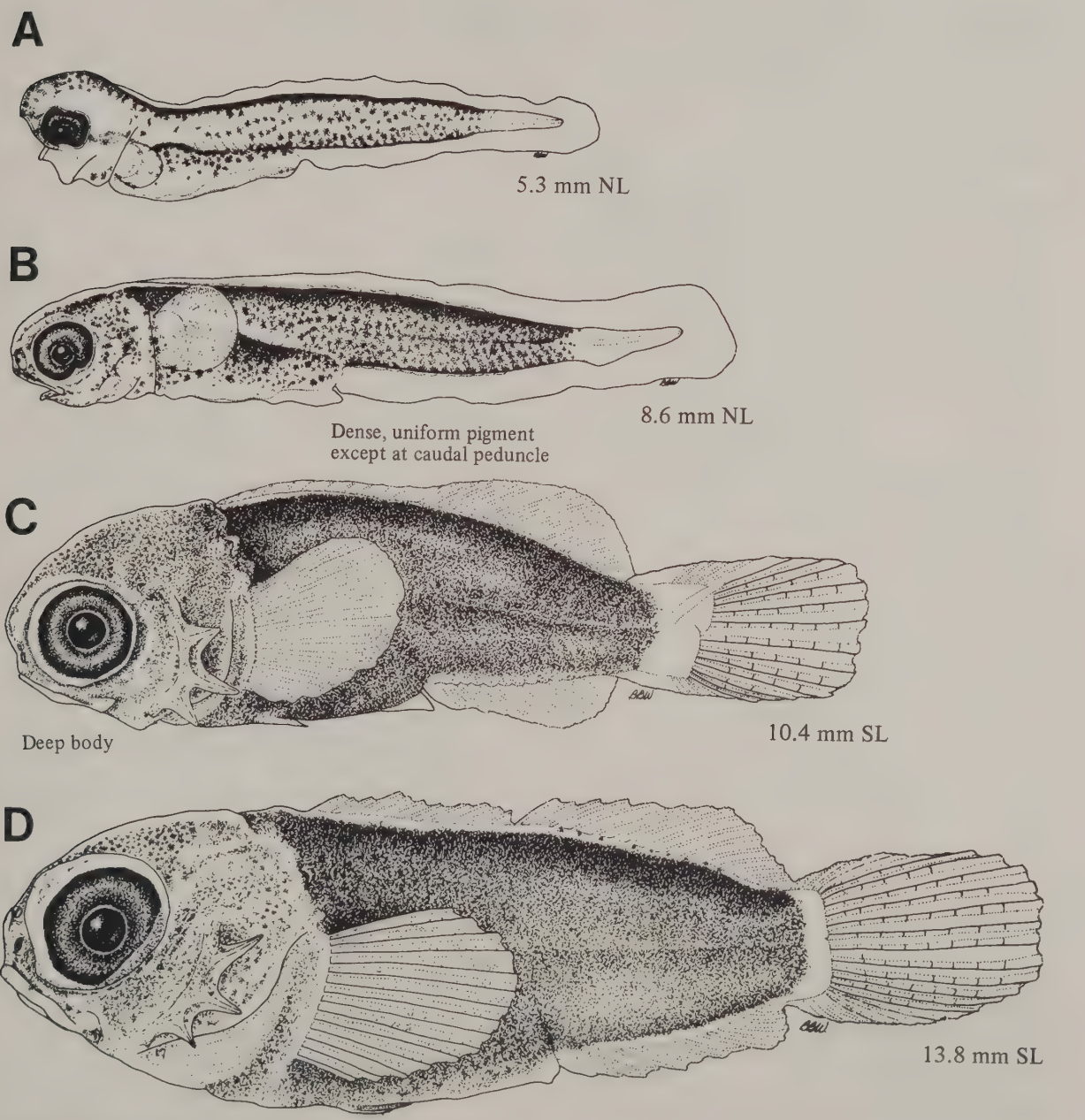
- Dense pigment covering body except for caudal peduncle

**Diagnostic characters** (see Table 3)

- Develops bony bumps on areas where head spines occur in *Hemilepidotus* spp.
- Becomes increasingly deep-bodied with development
- Uniformity of pigment

[a] O'Connell 1953
[b] Pillsbury 1957
[c] Feder et al. 1974
[d] Burge and Schultz 1973
[e] Wang 1981
[f] Richardson and Washington 1980

Ref: O'Connell 1953, Richardson and Washington 1980, Wang 1981, Washington et al. 1984b.




Figures A–D, Richardson and Washington 1980.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 33-33-35[a] | |
| | Precaudal: 11-11-11[b] | |
| | Caudal: 24-24-24[b] | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 2-3-3[c] |
| **Dorsal fin** | S: 9-10-10 | R: 14-16-17 |
| **Pectoral fin** | R: 14-15-16 | |
| **Anal fin** | R: 10-12-12 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | N. California, 38-42°N, to SE Alaska, 55-59°N |
| **Ecology** | Nearshore shelf demersal, intertidal to 82 m |
| **ELH pattern** | Parity and eggs unknown, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | ~3 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | 6.2-9.4 mm SL |
| **Length at transformation** | 13-19 mm SL |
| **Sequence of fin development** | Caudal, 2nd dorsal (rays) and anal, 1st dorsal (spines) and pectorals, pelvics (pectorals and pelvics formed by 11.5 mm SL) |

**Pigment**

- Low number (<15) ventral midline melanophores
- Dorsal and anal finfolds
- Base of cleithrum

**Diagnostic characters**

- Short gut (33% SL)
- Pointed snout
- Pigment (see above)
- Four preopercular spines, other spines (as for *Myoxocephalus* group)
- Pelvic fin ray count I,2; visible in late-stage larvae and juveniles

[a] Total myomere count from Figures A and B = 36.
[b] B.B. Washington, NMFS Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560, unpubl.
[c] I,2 is the most common count. The first ray is greatly thickened and broadly branched distally, probably leading to the erroneous counts of I,3 in the literature (B.B. Washington, pers. commun., 8 Dec. 1986).

Ref: Richardson and Washington 1980 (as *Icelinus* spp.), Washington 1986, Washington et al. 1984b.

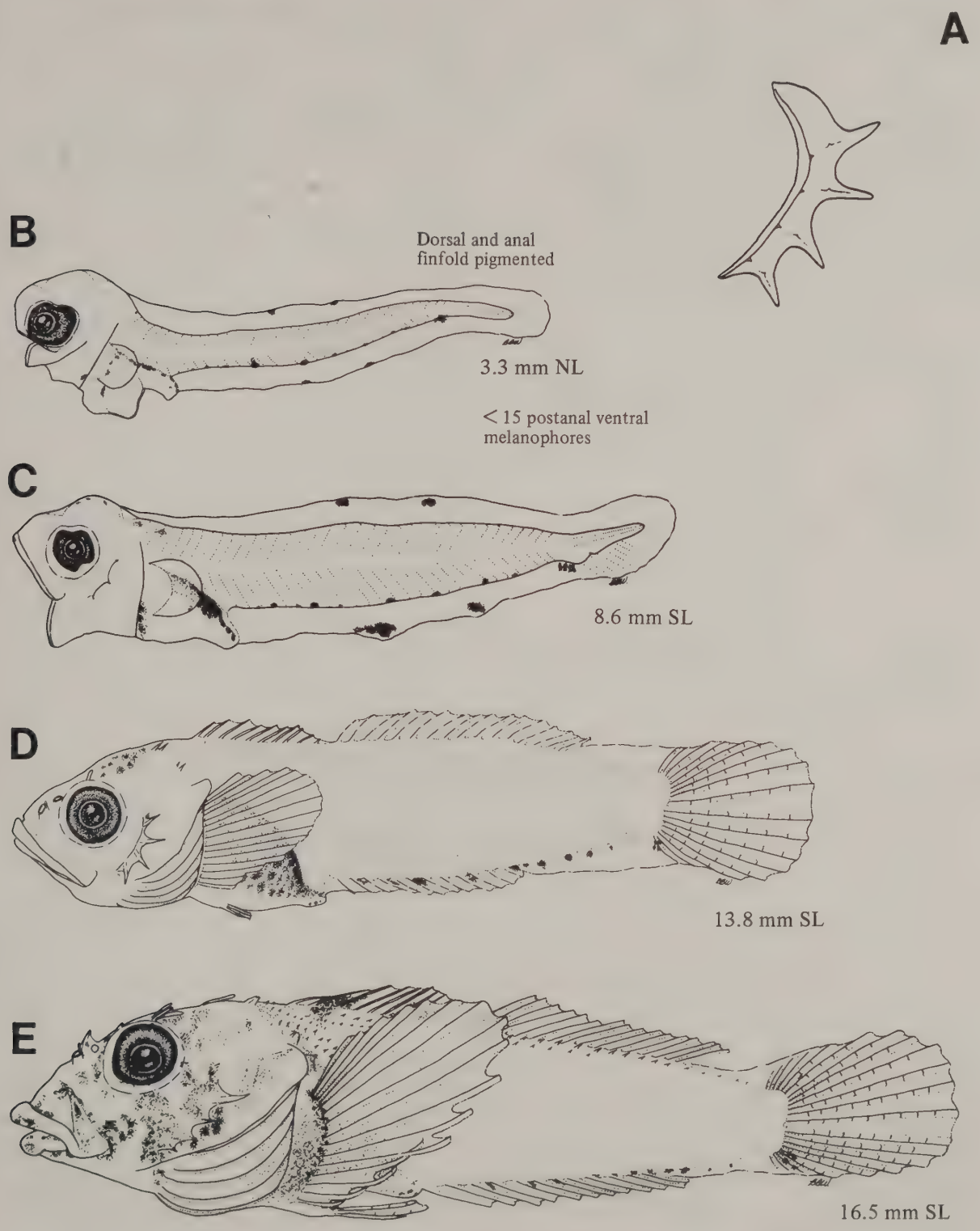



Figure A, Washington 1986; B–E, Richardson and Washington 1980. Total myomere counts for Figures B and C are 36.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 33-36-36 | |
| | Precaudal: 10-11-12 | |
| | Caudal: 24-25-25 | |
| **Branchiostegal rays** | 6-6-7 | |
| **Caudal fin** | 10-13, 6+7, 8-11 | |
| **Pelvic fin** | Absent | |
| **Dorsal fin** | S: 7-9-10 | R: 17-18-19 |
| **Pectoral fin** | R: 16-17-18 | |
| **Anal fin** | R: 13-15-16 | |
| **Gill rakers** | U: 0-X-3 | L: 3-X-5 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Cent. California, 34-38°N, to SE Alaska, 55-59°N |
| **Ecology** | Intertidal, nearshore shelf demersal |
| **ELH pattern** | Oviparous; demersal, adhesive eggs; pelagic larvae |
| **Spawning** | Season: Mar (British Columbia)[a] |
| | Area: Cobble beach, under boulders[a] |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.7-2.0 mm |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous, transparent blue developing to purple |
| **Envelope** | Smooth |
| **Hatch size** | 6 mm SL |
| **Incubation time/temp.** | 24 d/10°C |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | 8.8-11.0 mm SL |
| **Length at transformation** | 12-13 mm SL |
| **Sequence of fin development** | |

**Pigment**

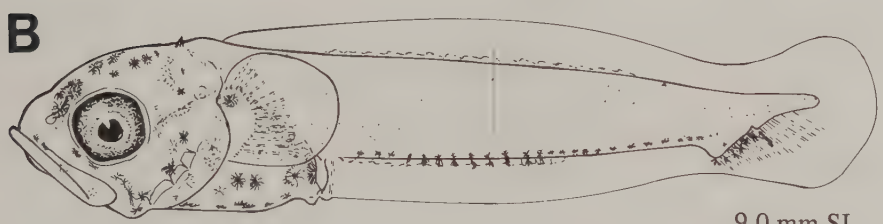
- Heavy pigment on head and gut
- 20-30 ventral midline melanophores prior to flexion, 15-20 in postflexion larvae

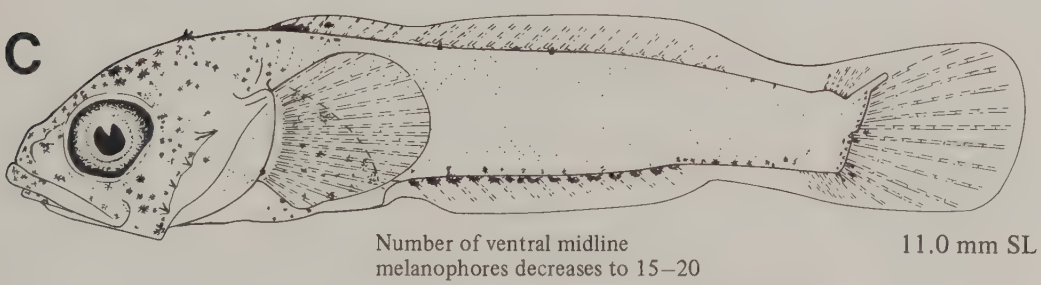
**Diagnostic characters**

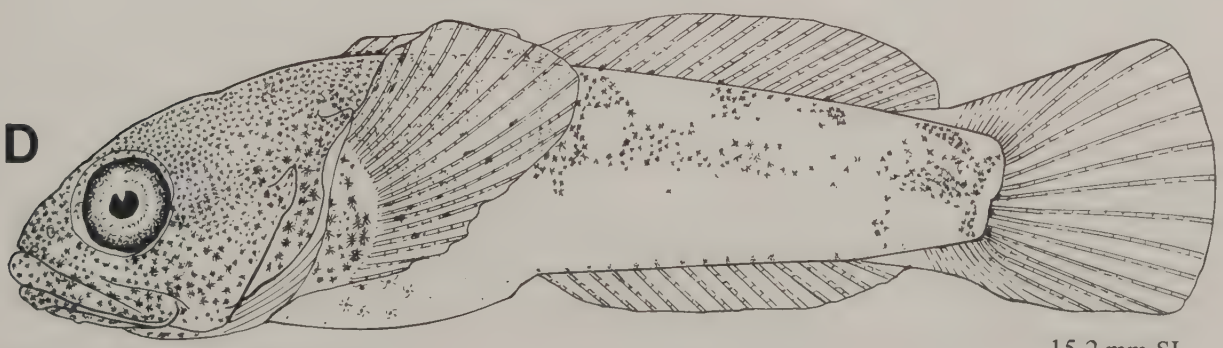
- Moderately slender form
- Pointed snout
- Four preopercular spines
- Ventral midline melanophores (the number at various developmental stages)

[a] Matarese and Marliave 1982

Ref: Matarese and Marliave 1982.




Figures A–D, Matarese and Marliave 1982.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 35-35-36 | |
| | Precaudal: 10-11-11 | |
| | Caudal: 24-25-25 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | X, 6+6, X | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 2-3-3 |
| **Dorsal fin** | S: 8-10-11 | R: 14-16-17 |
| **Pectoral fin** | R: 16-17-18 | |
| **Anal fin** | R: 14-16-17 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Brit. Col., 48°30′-55°N |
| **Ecology** | Nearshore shelf demersal, intertidal to 142 m |
| **ELH pattern** | Oviparous; adhesive, demersal eggs; pelagic larvae |
| **Spawning** | Season: Winter-spring (Calif.)[a]<br>Area:<br>Mode: Internal fertilization[b]<br>Migration: |
| **Fecundity** | Range/function: 450-1900 ($\bar{x}$ 1043) may produce three clutches/season[a] |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.02-1.05 mm |
| **No. of oil globules** | One large, 5-8 small |
| **Oil globule diameter** | 0.3 mm (large) |
| **Yolk** | |
| **Envelope** | Salmon-colored |
| **Hatch size** | 2.9-3.0 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | |
| **Length at transformation** | Begins ~16.6 mm SL |
| **Sequence of fin development** | Caudal first, pelvics last |

**Pigment**

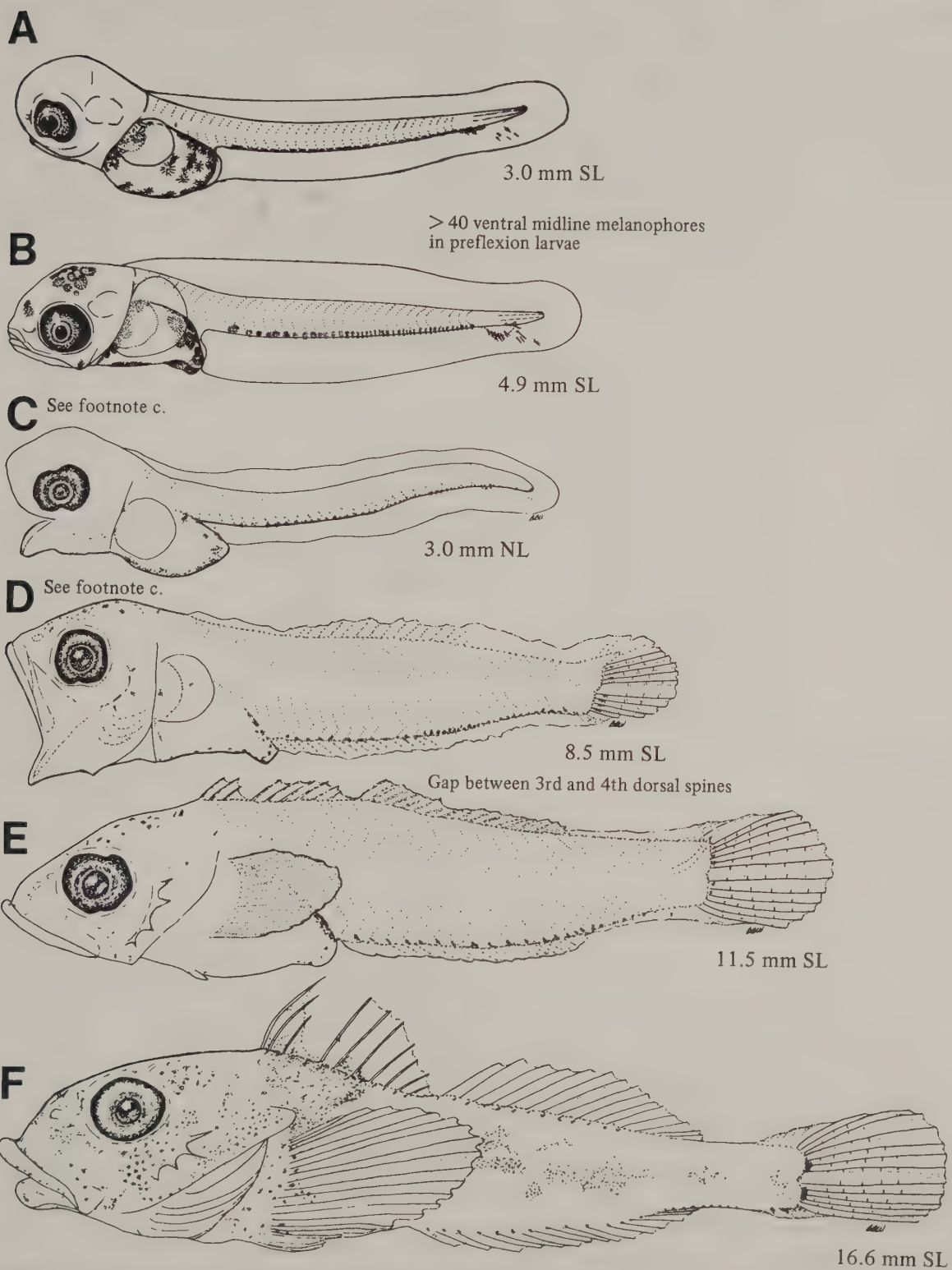
- Dorsolateral gut pigment generally light according to Richardson and Washington (1980),[c] but specimens we collect have heavier pigment (compare Figures A and B with C and D)
- Our specimens have heavy crown pigment

**Diagnostic characters**

- Number of ventral midline melanophores >40 in preflexion larvae (<6 mm SL) and >20 in others
- Upper two preopercular spines larger than lower two

[a] Goldberg 1980b
[b] Misitano 1980
[c] Richardson suspects Figures C and D are incorrect; series requires reevaluation (S.L. Richardson, deceased, pers. commun., Oct. 1984). Washington suspects they are *Icelinus*, probably *I. quadriseriatus*, which occurs outside our study area (B.B. Washington, NMFS Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560, pers. commun., 8 Dec. 1986).

Ref: Misitano 1980, Richardson and Washington 1980, Washington et al. 1984b.




Figures A–B, NWAFC originals (B. Vinter); C–F, Richardson and Washington 1980.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 29-31-31 | |
| | Precaudal: 11-11-12 | |
| | Caudal: 18-20-20 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 3-3-3 |
| **Dorsal fin** | S: 7-8-9 | R: 9-12-13 |
| **Pectoral fin** | R: 15-16-17 | |
| **Anal fin** | R: 8-9-10 | |
| **Gill rakers** | U: 0-X-1 | L: 4-X-6 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Cent. California, 34-38°N, to Gulf of Alaska, 54-60°N |
| **Ecology** | Nearshore shelf demersal, 0-20 m |
| **ELH pattern** | Oviparous; adhesive, demersal, guarded eggs; pelagic larvae |
| **Spawning** | Season: Feb-May (Puget Sound)[a]<br>Area: On rocks or pilings nearshore[a]<br>Mode: Internal fertilization likely,[b] polygamous male guards nests[c]<br>Migration: |
| **Fecundity** | Range/function: 18,800-31,900 (spawn twice each season)[a] |
| **Age at first maturity** | |
| **Longevity** | |

[a] DeMartini 1978
[b] Andriashev 1954
[c] Misitano 1978

Ref: Misitano 1978, Richardson and Washington 1980, Washington et al. 1984b.

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.7-2.0 mm |
| **No. of oil globules** | One |
| **Oil globule diameter** | 0.36 mm |
| **Yolk** | Homogeneous, orange |
| **Envelope** | Clear, orange-brown |
| **Hatch size** | 4.9-5.2 mm SL (5 mm SL) |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 48-55% SL |
| **Length at flexion** | 5.2-7.0 mm SL |
| **Length at transformation** | 7.6-7.8 mm SL |
| **Sequence of fin development** | Caudal first; pectorals and pelvics formed by 9 mm SL |

**Pigment**

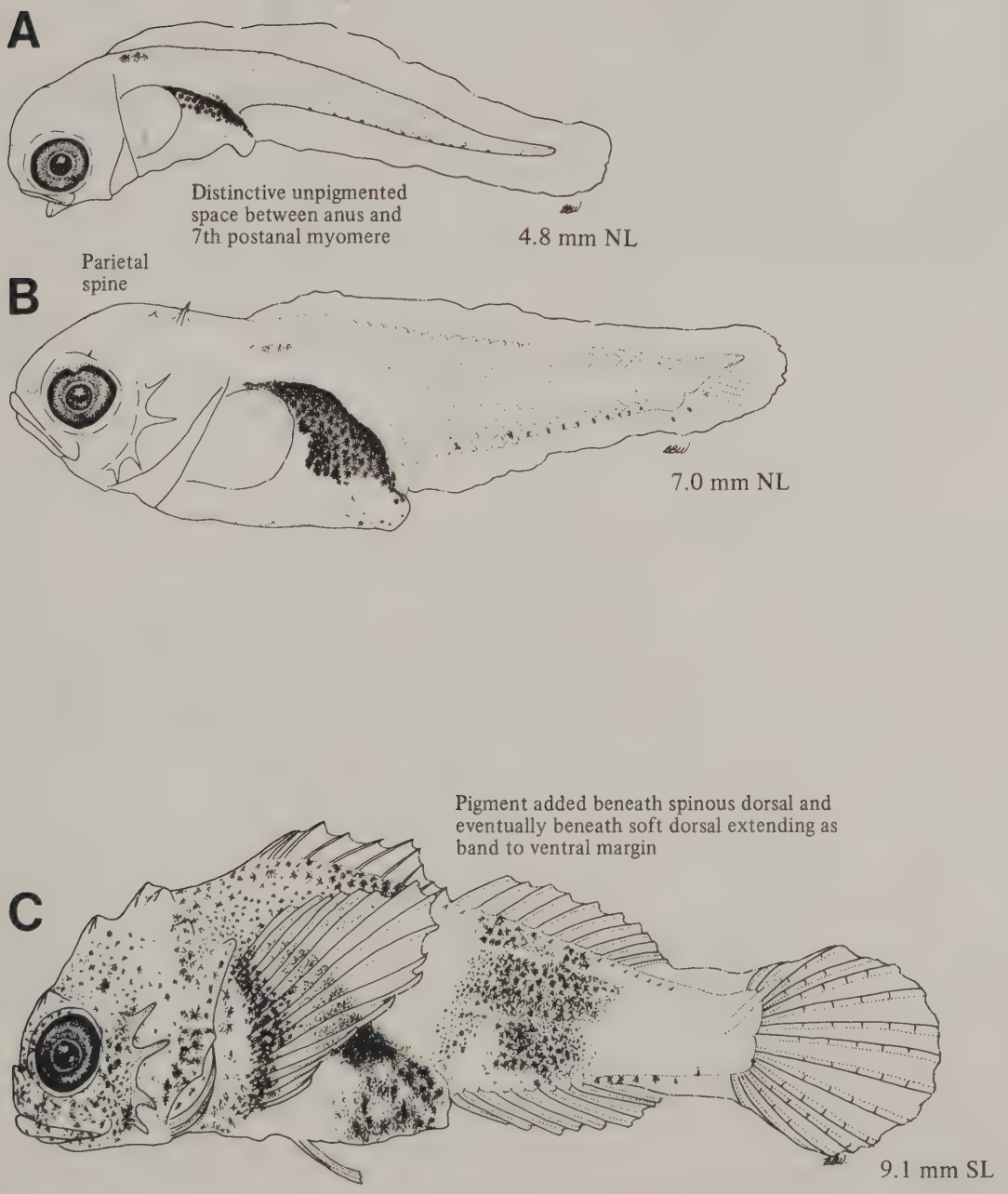
- Dorsal surface of gut
- Ventral midline melanophores (≤15)
- Nape

**Diagnostic characters**

- Only stout-bodied member of *Myoxocephalus* group
- Ventral midline: ≤15 melanophores beginning several myomeres after anus
- Four preopercular spines
- Head spines prominent (e.g., parietal)
- Low vertebral count (29-31)

Eggs and larvae of *E. diceraus* and *E. lucasi* are unknown. The following information may aid in their identification.

| | *E. diceraus* | *E. lucasi* |
|---|---|---|
| Total vertebrae | 31-35 | 32-34 |
| Dorsal fin spines | 7-8 | 7-8 |
| Dorsal fin rays | 13-15 | 12-14 |
| Anal fin rays | 11-13 | 9-11 |
| Pectoral fin rays | 15-19 | 15-18 |
| Pelvic fin rays | 2-3 | 2-3 |
| Range | SE Alaska-Arctic | Brit. Col.-Bering Sea |


A
Distinctive unpigmented space between anus and 7th postanal myomere
4.8 mm NL
Parietal spine
B
7.0 mm NL
Pigment added beneath spinous dorsal and eventually beneath soft dorsal extending as band to ventral margin
C
9.1 mm SL

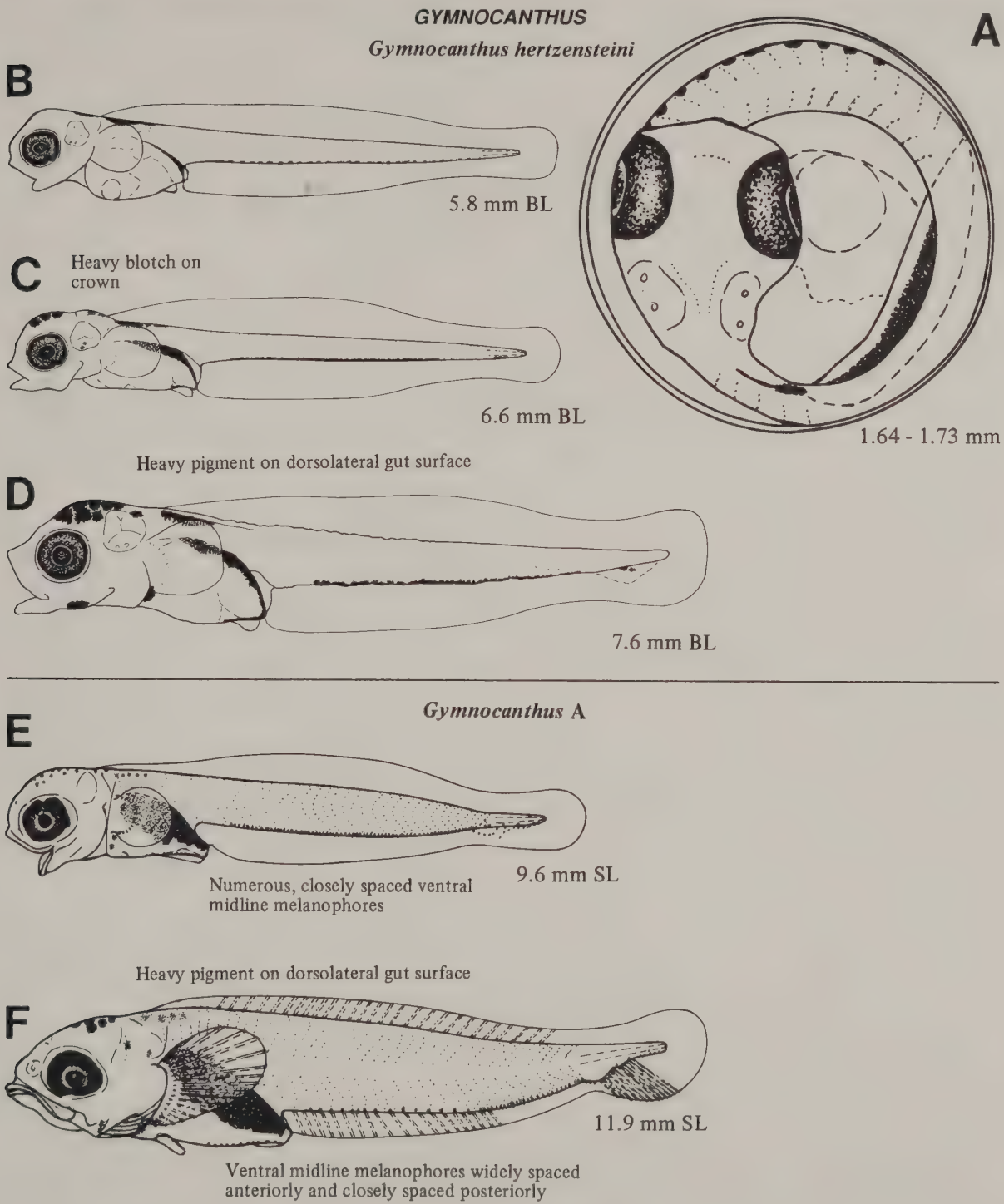
Figures A–C, Richardson and Washington 1980.

Presently we cannot identify to species *Gymnocanthus* larvae from samples collected in our study area. We identify one type, *Gymnocanthus* A, and include illustrations of *G. hertzensteini* for comparison. Generic characters include:

- Patch of pigment on crown
- Heavy dorsal pigment on gut, increasing dorsolaterally with development
- Numerous, closely spaced, ventral midline melanophores in preflexion larvae

The following meristic information may aid in their identification.

| | | | Fins | | | | |
|---|---|---|---|---|---|---|---|
| | | | Dorsal | | | | |
| Species | Distribution | Vertebrae | Spines | Rays | Anal rays | Pectoral rays | Pelvic rays |
| *Gymnocanthus detriscus* | Bering Sea | 37-39 | IX-XI | 15-18 | 15-19 | 19-20 | I,3 |
| *Gymnocanthus galeatus* | Brit. Col. - Bering Sea | 37-40 | X-XII | 14-17 | 17-20 | 19-21 | I,3 |
| *Gymnocanthus pistilliger* | SE Alaska - Bering Sea | 35-38 | IX-XI | 13-16 | 14-18 | 15-20 | I,3 |
| *Gymnocanthus tricuspis* | Bering Sea - Arctic | 36-40 | X-XII | 15-17 | 15-18 | 17-20 | I,3 |




Figures A–D, Kyushin 1970 (reared from specimens collected near Hokkaido, Japan; B–D, redrawn); E–F, NWAFC originals (B. Vinter).

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 36-38-40 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 3-3-3 |
| **Dorsal fin** | S: 10-11-12 | R: 15-15-17 |
| **Pectoral fin** | R: 17-18-20 | |
| **Anal fin** | R: 15-17-18 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Bering Sea, 54-66°N, to Arctic (throughout) |
| **Ecology** | Epi- and mesobenthal, 0-240 m |
| **ELH pattern** | Oviparous, demersal eggs, pelagic larvae |
| **Spawning** | Season: Winter-spring[a] |
| | Area: |
| | Mode: Internal fertilization likely[a] |
| | Migration: |
| **Fecundity** | Range/function: 2000-3500 (117-158 mm specimens)[a] |
| **Age at first maturity** | 4 yr[a] |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 2 mm |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

**Preanal length**
**Length at flexion**
**Length at transformation**
**Sequence of fin development**
**Pigment**[b]

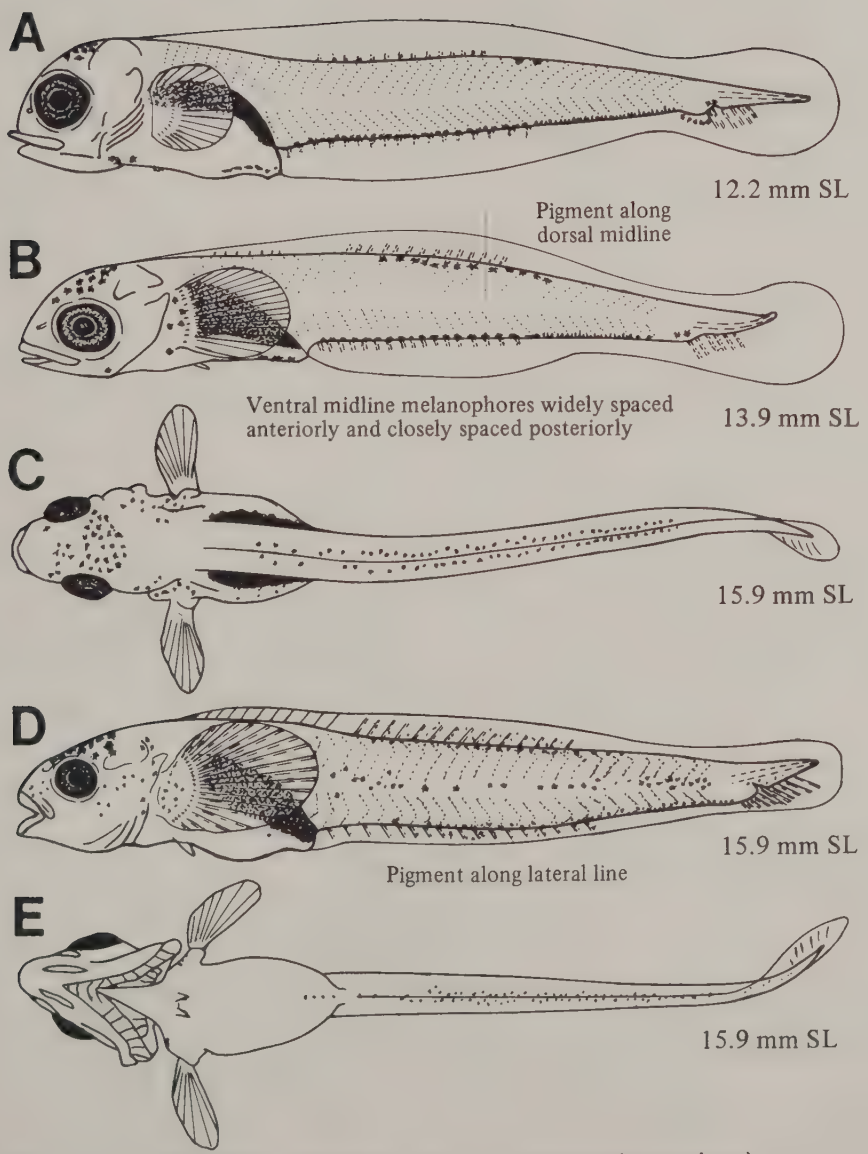
- Heavy pigment on crown and dorsolateral surface of gut
- Larvae >12.2 mm SL have pigment along dorsal midline, and larvae >13.9 mm SL develop pigment along lateral line
- Ventral midline melanophores are widely spaced anteriorly and closely spaced posteriorly

**Diagnostic characters**

- Specimens of other species of *Gymnocanthus* at comparable developmental stages have not been described

[a] Andriashev 1954
[b] Specimens have not been collected from our study area. Illustrations of out-of-area specimens are presented for comparison and may differ.

Ref: Andriashev 1954, Khan 1972, Washington et al. 1984b.




Figures A–E (C, dorsal view; E, ventral view), Khan 1972 (Atlantic specimens, redrawn).

Eggs and larvae of *Icelinus* spp. from the study area are unknown. Illustrations of *Icelinus* A and B, both tentatively identified as *I. borealis* by Washington and Richardson (unpubl.),[1] are presented here.

The following meristic characters may aid in their identification.

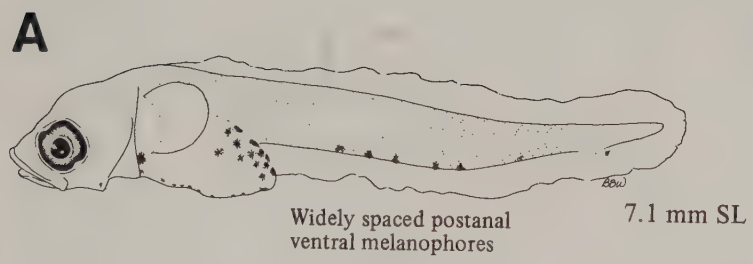
| | | | Fins | | | | |
|---|---|---|---|---|---|---|---|
| | | | Dorsal | | | | |
| Species | Distribution | Vertebrae | Spines | Rays | Anal rays | Pectoral rays | Pelvic rays |
| *Icelinus borealis* | Wash. - Bering Sea | 35-36 | IX-XI | 14-17 | 11-14 | 14-17 | I,2 |
| *Icelinus burchami* | S. Calif. - SE Alaska | 35-37 | X-XI | 16-18 | 12-14 | 16-19 | I,2 |
| *Icelinus filamentosus* | S. Calif. - Gulf of Alaska | 34-37 | X-XII | 15-17 | 13-16 | 16-18 | I,2 |
| *Icelinus fimbriatus* | S. Calif. - Brit. Col. | 37 | XI | 15-17 | 13-14 | 17 | I,2 |
| *Icelinus tenuis** | SSC - Brit. Col. | 37-39 | IX-XI | 16-18 | 14-17 | 15-17 | I,2 |

*A partial series of *I. tenuis* larvae has been identified at Los Angeles County Museum (R. Feeney, Los Ang. Cty. Mus. Nat. Hist., 900 Exposition Blvd., Los Angeles, CA 90007, pers. commun., Oct. 1986).

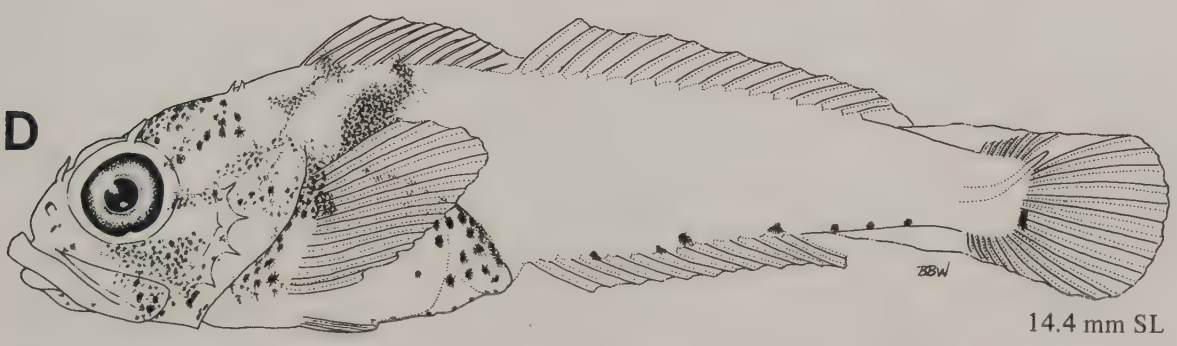
[1]B.B. Washington, NMFS Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560.

## *ICELINUS*

*Icelinus* A




*Icelinus* B




Figures A–D, Washington and Richardson, unpubl.

Eggs and larvae of *Icelus* spp. from our study area are unknown. The following meristic characters may aid in their identification.

| | | | Fins | | | | |
|---|---|---|---|---|---|---|---|
| | | | Dorsal | | | | |
| Species | Distribution | Vertebrae | Spines | Rays | Anal rays | Pectoral rays | Pelvic rays |
| *Icelus canaliculatus* | Gulf of Alaska - Bering Sea | 41 | VII-VIII | 22-25 | 18-20 | 15-19 | I,3 |
| *Icelus euryops* | Gulf of Alaska - Bering Sea | | VIII-X | 20-23 | 15-19 | 16-18 | I,3 |
| *Icelus scutiger** | Gulf of Alaska - Bering Sea | 39-41 | IX-X | 18-21 | 17-19 | 17-19 | I,3 |
| *Icelus spatula* | Gulf of Alaska - Arctic | 39-41 | VII-X | 17-22 | 13-18 | 16-20 | I,3 |
| *Icelus spiniger* | Brit. Col. - Bering Sea | 40-42 | VIII-X | 19-24 | 15-20 | 17-20 | I,3 |
| *Icelus uncinalis* | Bering Sea | 37-40 | IX-X | 18-20 | 14-16 | 17-18 | I,3 |

*Placed in the genus *Rastrinus* by D.W. Nelson (1984).

Presently we cannot identify to species *Myoxocephalus* larvae from samples we collect in our study area. We collect at least two types based on the following pigmentation characters:

***Myoxocephalus* B** Ventral midline melanophore series (>40 spots), dorsal pigment on gut, and crown pigment; with development, dorsolateral pigment appears covering about 2/3 body length, small ventrolateral patch appears at midbody. Ventrolateral body from over gut to about six myomeres after anus is unpigmented.

***Myoxocephalus* G (probably *M. polyacanthocephalus*)** Preflexion pigment pattern similar to flexion pattern of the other *Myoxocephalus* type; crown, gut, and ventral midline series with dorsolateral and lateral pigment covering 2/3 body length. Body pigment becomes more intense and crown pigment covers entire head with development. No unpigmented area on lateral body over gut and anus.

The following meristic characters may aid in their identification.

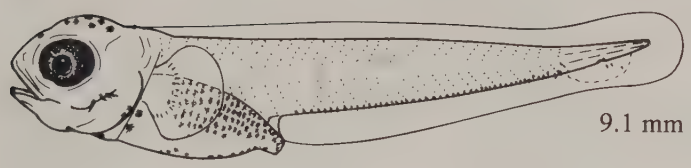
| | | | Fins | | | | |
|---|---|---|---|---|---|---|---|
| | | | Dorsal | | | | |
| Species | Distribution | Vertebrae | Spines | Rays | Anal rays | Pectoral rays | Pelvic rays |
| *Myoxocephalus axillaris** | Bering Sea - Arctic | | VIII-X | 15-17 | 11-13 | 14-16 | I,3 |
| *Myoxocephalus brandti* | Bering Sea | | IX | 15 | 12-13 | 16-17 | I,3 |
| *Myoxocephalus jaok* | Gulf of Alaska - Chukchi Sea | 35-38 | VIII-XI | 13-17 | 12-16 | 17-19 | I,3 |
| *Myoxocephalus niger* | Bering Sea | 36-39 | VIII-X | 14-18 | 10-12 | 16-18 | I,3 |
| *Myoxocephalus polyacanthocephalus* | Wash. - Bering Sea | 34-37 | IX-X | 10-15 | 8-13 | 16-19 | I,3 |
| *Myoxocephalus quadricornis* | Bering Sea - Arctic | 38-42 | VII-X | 12-16 | 13-17 | 14-18 | I,3 |
| *Myoxocephalus scorpioides** | Bering Sea - Arctic | 35-38 | VIII-X | 13-18 | 10-14 | 14-17 | I,3 |
| *Myoxocephalus scorpius** | SE Alaska - Arctic | 38-46 | VIII-XII | 12-20 | 10-16 | 16-19 | I,3 |
| *Myoxocephalus stelleri* | Bering Sea - Chukchi Sea | | VIII-X | 15-16 | 11-14 | 16-18 | I,3 |
| *Myoxocephalus verrucosus** | Brit. Col. - Arctic | | IX-XII | 15-18 | 13-15 | 16-19 | I,3 |

*According to Neelov (1979), *M. scorpioides* = *M. axillaris*, and *M. scorpius* in the study area is *M. verrucosus*.

***MYOXOCEPHALUS***

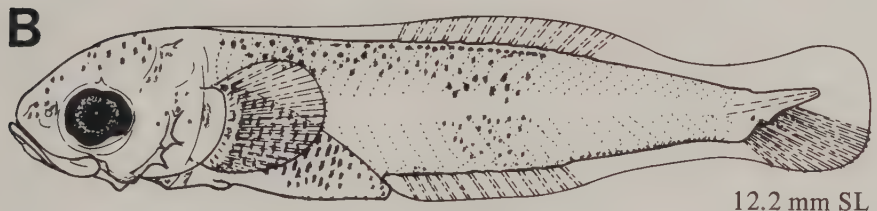
*Myoxocephalus* B

A



9.1 mm SL

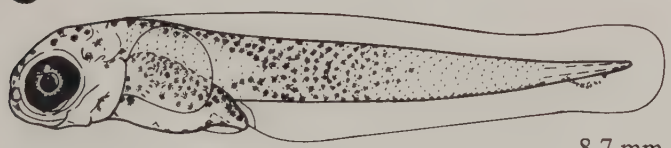
B



12.2 mm SL

*Myoxocephalus* G

C



8.7 mm SL

*M. polyacanthocephalus*

D

12.2 mm SL

Figures A–C, NWAFC originals (B. Vinter); D, Richardson 1981a.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 38-X-46 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 3-3-3 |
| **Dorsal fin** | S: 8-X-12 | R: 12-X-20 |
| **Pectoral fin** | R: 16-X-19 | |
| **Anal fin** | R: 10-X-16 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Brit. Col., 48°30′-55°N, to Arctic, not specific |
| **Ecology** | Epi-, meso-, and bathybenthal, 0-550 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Winter[b]<br>Area:<br>Mode: Eggs guarded by males[b]<br>Migration: |
| **Fecundity** | Range/function: 2700[b] |
| **Age at first maturity** | 3-4 yr[b] |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 2.0-2.5 mm;[b] 1.8-2.5 mm[c] |
| **No. of oil globules** | Several |
| **Oil globule diameter** | 0.4-0.5 mm |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | 7.4-8.6 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | |
| **Length at flexion** | 9-15 mm SL |
| **Length at transformation** | 17-20 mm SL |
| **Sequence of fin development** | |

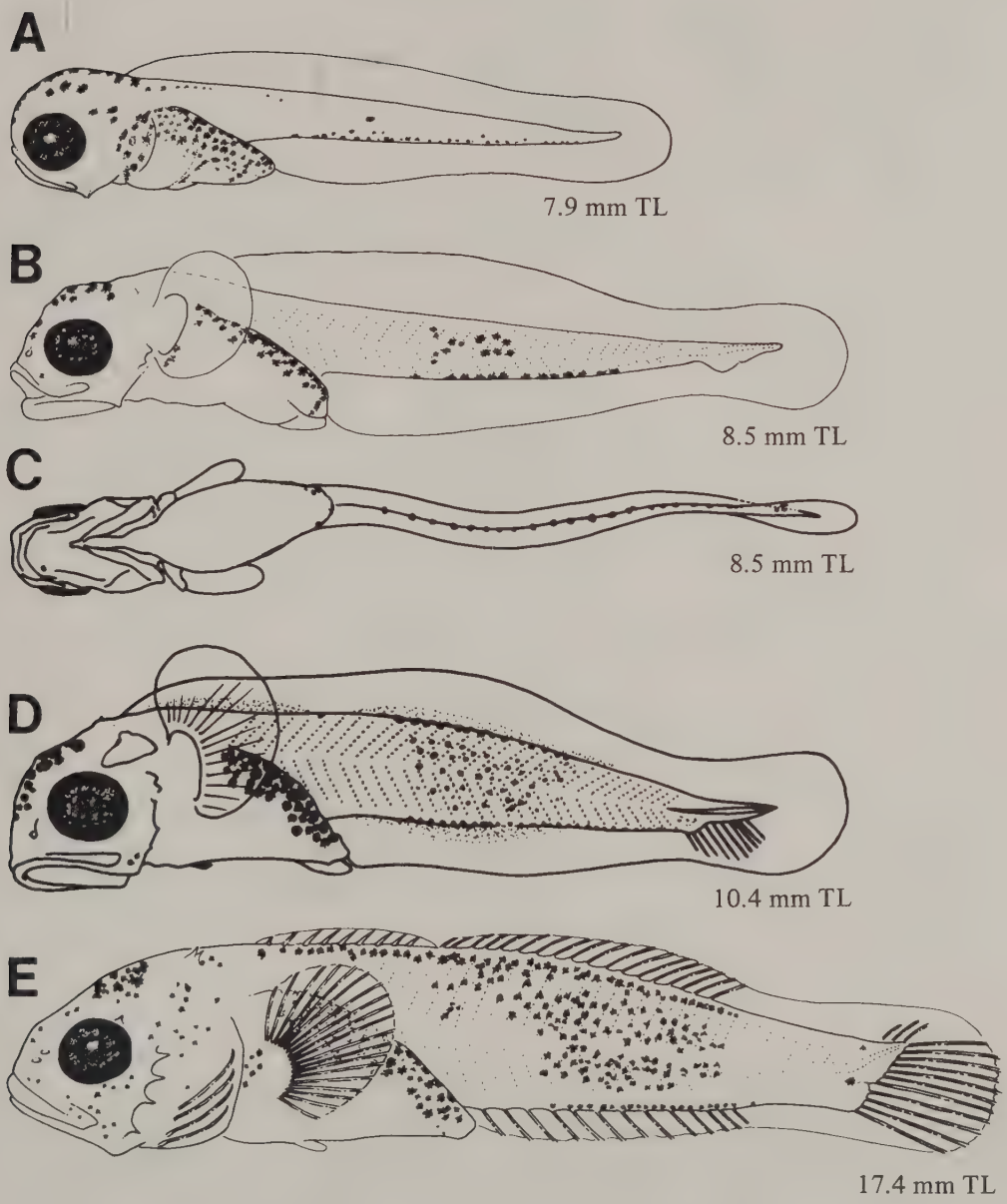
**Pigment**

- Crown, dorsolateral gut surface, ventral midline starting at myomere 16
- Develops midbody patch at flexion with dorsal pigment extending anteriorly

**Diagnostic characters**

[a] According to Neelov (1979), specimens from our area are *M. verrucosus*. Illustrations of Atlantic specimens of *M. scorpius* are presented for comparison. Specimens from our area may differ.
[b] Andriashev 1954
[c] Washington et al. 1984b

Ref: Andriashev 1954, Washington et al. 1984b.




Figures A–B, E, Fahay 1983 (A, after Rass 1949; B, E, after Khan 1972); C–D (C, ventral view), Khan 1972 (B–E, Gulf of St. Lawrence specimens).

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 42-42-43 | |
| | Precaudal: 12-12-12[a] | |
| | Caudal: 31-31-31[a] | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 5-5-5 |
| **Dorsal fin** | S: 12-13-13 | R: 19-19-20 |
| **Pectoral fin** | R: 14-15-15 | |
| **Anal fin** | R: 23-24-24 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Brit. Col., 48°30′-55°N |
| **Ecology** | Nearshore shelf demersal, 0-183 m |
| **ELH pattern** | Parity and eggs unknown, pelagic larvae |
| **Spawning** | Season:<br>Area:<br>Mode:<br>Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | <5.6 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 35-36% SL, increasing with development |
| **Length at flexion** | |
| **Length at transformation** | ~25 mm SL |
| **Sequence of fin development** | |

**Pigment**

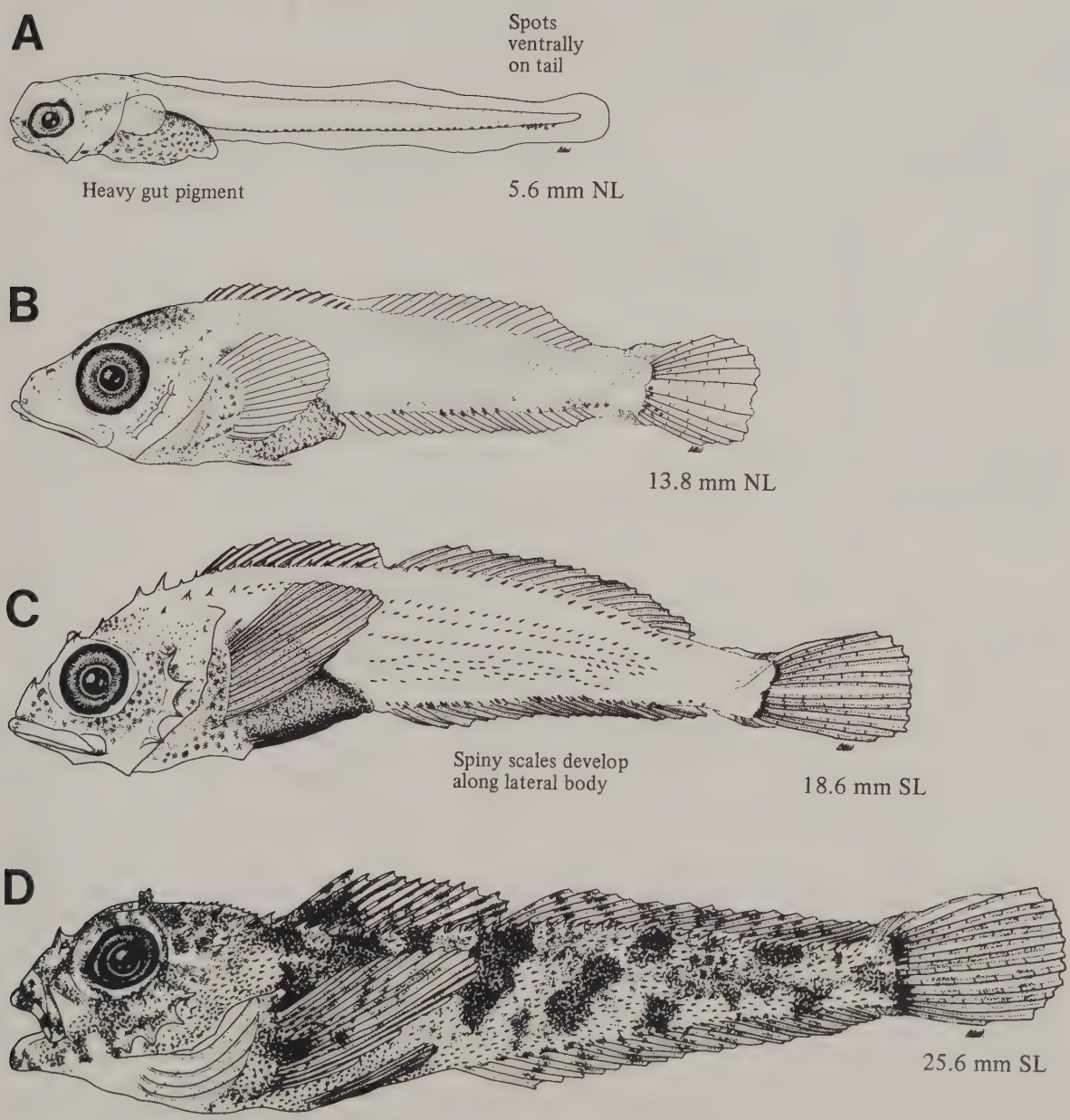
- Gut pigmented all over
- Ventral midline melanophores >30, decreasing to 15-20 by postflexion stage
- Melanophores near tail tip

**Diagnostic characters**

- Pigment pattern (tail pigment)
- Pointed snout and slender body
- Four preopercular spines
- Myomeres (42-43)
- Spiny scales develop in postflexion larvae

[a] B.B. Washington, NMFS Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560, unpubl.

Ref: Richardson and Washington 1980.




Figures A–D, Richardson and Washington 1980.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 38-39-40 | |
| | Precaudal: 12-X-13 | |
| | Caudal: 27-27-27 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 3-3-3 |
| **Dorsal fin** | S: 8-9-10 | R: 20-22-23 |
| **Pectoral fin** | R: 17-18-20 | |
| **Anal fin** | R: 21-23-25 | |
| **Gill rakers** | U: X-X-1 | L: 7-X-8 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Gulf of Alaska, 54-60°N |
| **Ecology** | Epi- and mesobenthal, 18-283 m |
| **ELH pattern** | Oviparous, demersal eggs, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous |
| **Envelope** | |
| **Hatch size** | ⩽4.7 mm NL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 44-54% SL |
| **Length at flexion** | 7.2-10.9 mm NL |
| **Length at transformation** | ⩾14-15 mm SL |
| **Sequence of fin development** | |

**Pigment**

- Heavy over body except dorsolaterally above body midline over gut and dorsally and laterally on tail tip

**Diagnostic characters** (see Table 3)

- Heavy pigmentation
- Preopercular spines not prominent
- Gut distinctively coiled

Distinguished from *Scorpaenichthys marmoratus* (p. 382) by

- Series of melanophores along lateral line

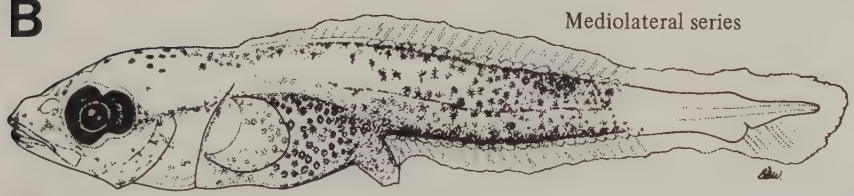
Ref: Richardson and Washington 1980, Washington et al. 1984b.

A

4.7 mm NL

B

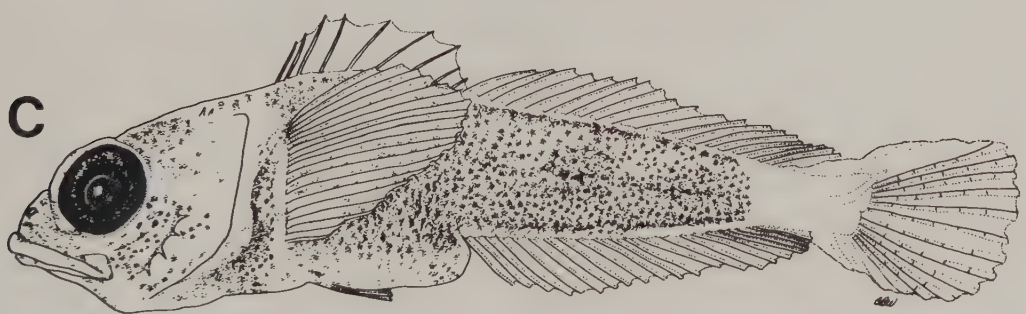
Mediolateral series



Pointed head

9.6 mm NL

C



12.6 mm SL

D

14.4 mm SL

Figures A–D, Richardson and Washington 1980.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 39-40-40 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | X, 6+6, X | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 3-3-3 |
| **Dorsal fin** | S: 8-9-11 | R: 20-20-22 |
| **Pectoral fin** | R: 18-19-20 | |
| **Anal fin** | R: 21-22-23 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Brit. Col., 48°30′-55°N |
| **Ecology** | Nearshore shelf demersal, 15-146 m |
| **ELH pattern** | Oviparous, eggs probably demersal, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous |
| **Envelope** | |
| **Hatch size** | |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | ~58% SL |
| **Length at flexion** | ~8.7 mm SL |
| **Length at transformation** | |
| **Sequence of fin development** | |
| **Pigment** | |

- Generally heavily pigmented over anterior 3/4 body

**Diagnostic characters** (see Table 3)

Distinguished from *R. asprellus* by

- Greater portion of tail unpigmented
- Morphological differences
  - —Preanal length longer
  - —Greater body depth

Ref: Richardson and Washington 1980.

A

8.7 mm NL

Figure A, Richardson and Washington 1980.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 38-39-39 |
| | Precaudal: 12-12-12 |
| | Caudal: 26-26-26 |
| **Branchiostegal rays** | 6-6-6[a] |
| **Caudal fin** | 8-9, 6+5, 7-8 |
| **Pelvic fin** | Thoracic |
| | S: 1-1-1 R: 3-3-3 |
| **Dorsal fin** | S: 8-10-10 R: 19-20-21 |
| **Pectoral fin** | R: 21-22-24 |
| **Anal fin** | R: 18-20-21 |
| **Gill rakers** | U: X-X-X L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to SE Alaska, 55-59°N |
| **Ecology** | Intertidal, nearshore shelf demersal |
| **ELH pattern** | Oviparous; demersal, attached, adhesive eggs; pelagic larvae |
| **Spawning** | Season: Jan-Feb through Apr (British Columbia), larvae collected in spring;[b] May[c]<br>Area: Shallow, rocky subtidal areas (extreme nearshore), larvae collected 0 and 4 m from shore[b]<br>Mode: Internal fertilization, eggs laid in masses on *Laminaria* holdfasts (15-20 eggs/mass)[b]<br>Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous, pink (wild) |
| **Envelope** | |
| **Hatch size** | |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE[d]

| | |
|---|---|
| **Preanal length** | 37-42% SL |
| **Length at flexion** | 6.5-8.5 mm SL |
| **Length at transformation** | |
| **Sequence of fin development** | Pectorals and caudal, dorsal and anal, pelvics |

**Pigment**

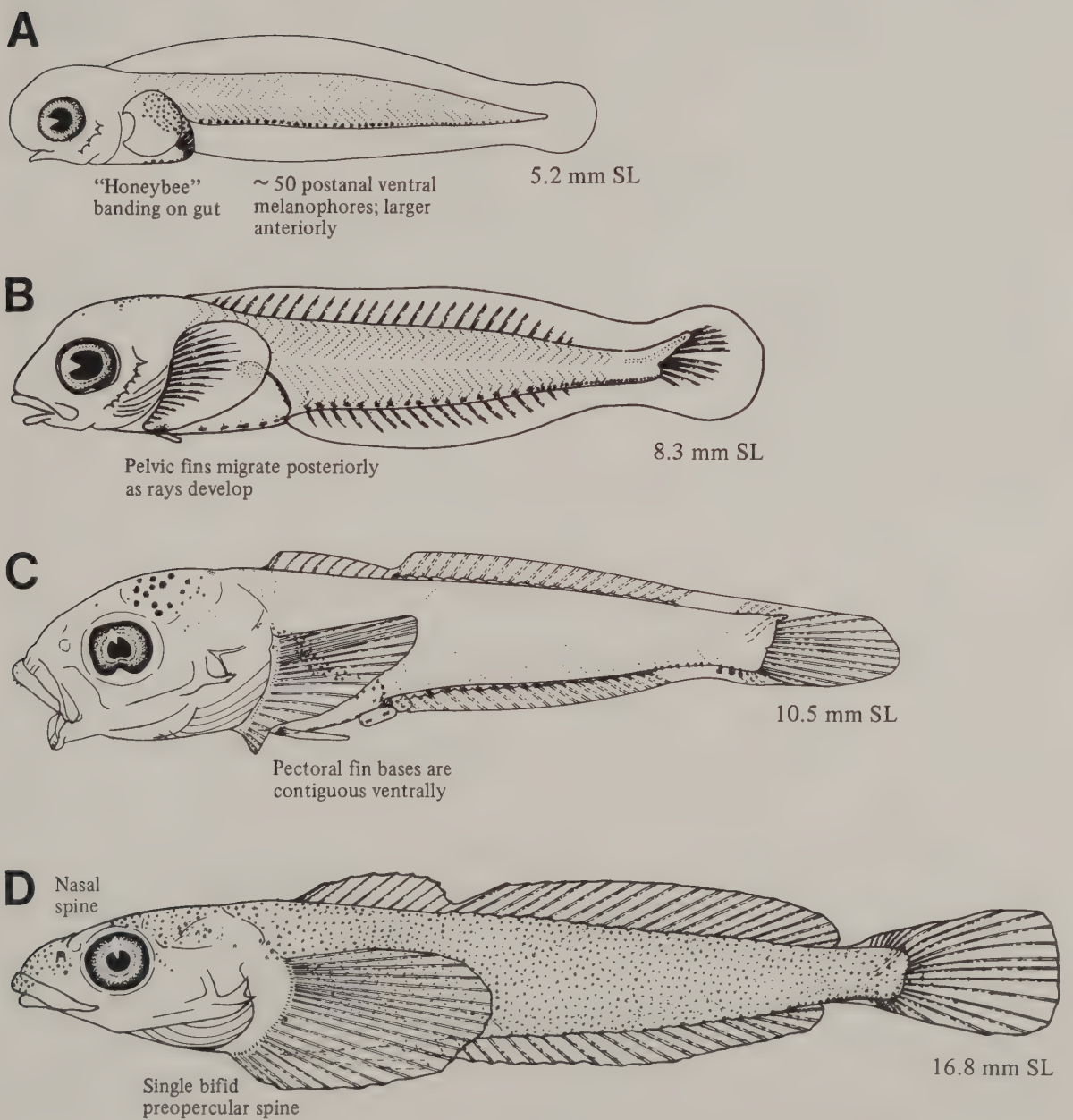
- Gut pattern
- High number of postanal ventral melanophores ($\bar{x}$ 51 in preflexion, 47 in flexion)

**Diagnostic characters**

- Pigment on gut
- Accessory or inner-shelf spines associated with preopercular spines in preflexion larvae (not present in other members of *Myoxocephalus* group)
- Pectoral fin rays develop toward each other ventrally
- Spines: Nasal spines develop at 12-14 mm SL

[a] According to Marliave et al. (1985), branchiostegal rays = 7.
[b] Marliave et al. 1985
[c] Hart 1973
[d] Tentative placement in *Myoxocephalus* group.

Ref: Marliave et al. 1985.




Figures A–B, Marliave et al. 1985; C–D, NWAFC originals (B. Vinter).

Presently we cannot identify to species *Triglops* spp. larvae from samples we collect in our study area. Illustrations of *Triglops* sp. (designated as B here) (Richardson and Washington 1980) and *Triglops* A (Washington and Richardson, unpubl.[1]) are presented here. Generic characters include:

- High myomere count (>45)
- Pointed snout
- Heavy dorsolateral pigmentation on gut
- Postanal ventral midline melanophores, probably becoming embedded in postflexion larvae (except *Triglops* B as figured by Richardson and Washington [1980]).

The following meristic information may aid in their identification.

| | | | Fins | | | | |
|---|---|---|---|---|---|---|---|
| | | | Dorsal | | | | |
| Species | Distribution | Vertebrae | Spines | Rays | Anal rays | Pectoral rays | Pelvic rays |
| *Triglops forficata* | Gulf of Alaska - Bering Sea | 52-54 | IX-XI | 27-32 | 27-32 | 20-22 | I,3 |
| *Triglops jordani* | Bering Sea | | IX-XI | 24-28 | 23-29 | 19-21 | I,3 |
| *Triglops macellus* | Wash. - Bering Sea | 51 | X-XI | 27-31 | 27-31 | 15-17 | I,3 |
| *Triglops metopias* | SE Alaska - Bering Sea | 48-49 | X-XI | 23-27 | 22-27 | 18-22 | I,3 |
| *Triglops pingeli* | Wash. - Arctic | 46-48 | IX-XIII | 22-28 | 20-28 | 16-19 | I,3 |
| *Triglops scepticus* | SE Alaska - Bering Sea | 45-46 | X-XII | 21-23 | 22-24 | 17-19 | I,3 |

[1]B.B. Washington, NMFS Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560.

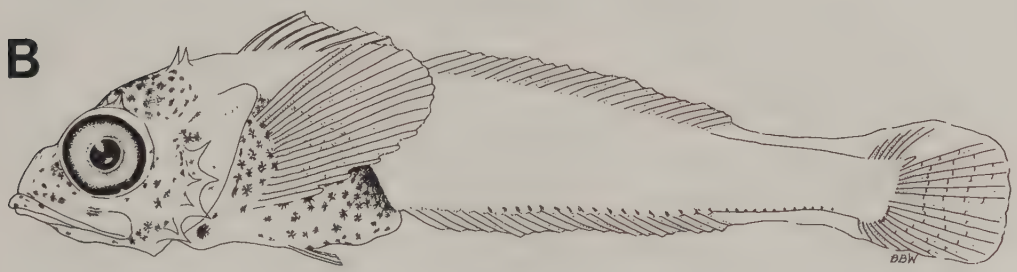
## *TRIGLOPS*

*Triglops* A (possibly *T. scepticus* based on counts)

A

Ventral midline melanophores 6.5 mm SL

B



16.9 mm SL

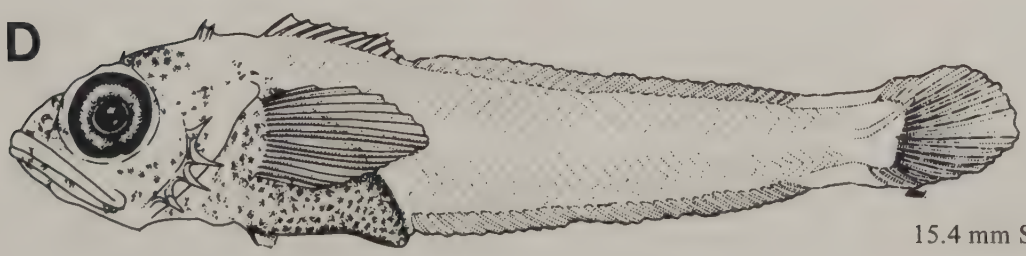
*Triglops* B

C

6.9 mm NL

Lack of postanal
body pigment

D



15.4 mm SL

Figures A–B, Washington, unpubl.; C–D, Richardson and Washington 1980.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 32-33-35 | |
| | Precaudal: 11-X-12[a] | |
| | Caudal: 22[a]-X-23 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | X, 6+6, X | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 3-3-3 |
| **Dorsal fin** | S: 8-9-10 | R: 16-17-18 |
| **Pectoral fin** | R: 14-15-16 | |
| **Anal fin** | R: 12-13-14 | |
| **Gill rakers** | U: 1-1-1 | L: 4-X-5 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Cent. California, 34-38°N, to Aleutian Is., 51-55°N |
| **Ecology** | Nearshore shelf demersal, intertidal to 55 m |
| **ELH pattern** | Oviparous; demersal, adhesive, attached eggs; pelagic larvae |
| **Spawning** | Season: Feb-May[b]<br>Area: Intertidal, under rocks[b]<br>Mode: Polygamous males, eggs laid in nests[b]<br>Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

[a] B.B. Washington, NMFS Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560, unpubl.

[b] Marliave 1975a

[c] Pigment patterns within the genus *Artedius* appear to be highly variable. Reared specimens vary between hatches and stages (J. Marliave, Vancouver Public Aquarium, P.O. Box 3232, Vancouver, B.C., Canada V6B 3X8, pers. commun., 16 Oct. 1986). Wild specimens collected from Yaquina Bay, Oregon, show variations from the pigment patterns described in Washington (1986) (B. Mundy, NMFS Southwest Fish. Cent., Honolulu Lab., 2570 Dole St., Honolulu, HI 96822, pers. commun., 1 Oct. 1986).

Ref: Marliave 1975a; Richardson and Washington 1980 (see *Artedius* 2); Washington 1981, 1986.

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous; blue, purple, or gray |
| **Envelope** | |
| **Hatch size** | 3.5-3.8 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | 5.9-6.8 mm NL |
| **Length at transformation** | 12-14 mm SL |
| **Sequence of fin development** | Caudal, dorsal and anal rays, dorsal spines, pectorals, pelvics |

**Pigment**[c]

- Lack of head pigment
- Usually relatively light nape pigment present
- 13-19 postanal ventral midline melanophores

**Diagnostic characters**

Distinguished from other cottids by

- Body shape stubby, humped
- Presence of gut diverticula
- Preopercular spines (postflexion, 18-22)
- Parietal spines (postflexion)

Distinguished from other *Artedius* spp. with gut diverticula by

| | Preflexion | | Flexion | |
|---|---|---|---|---|
| | No. of postanal ventral melanophores | Presence of nape pigment | Presence of brain pigment | No. of preopercular spines |
| *A. fenestralis* | 13-19 | Irreg. | No | 18-22 |
| *A. lateralis* | 22-32 | No | Yes | 14-16 |
| *Artedius* 3 | 9-13 | Yes | No | 22-24 |

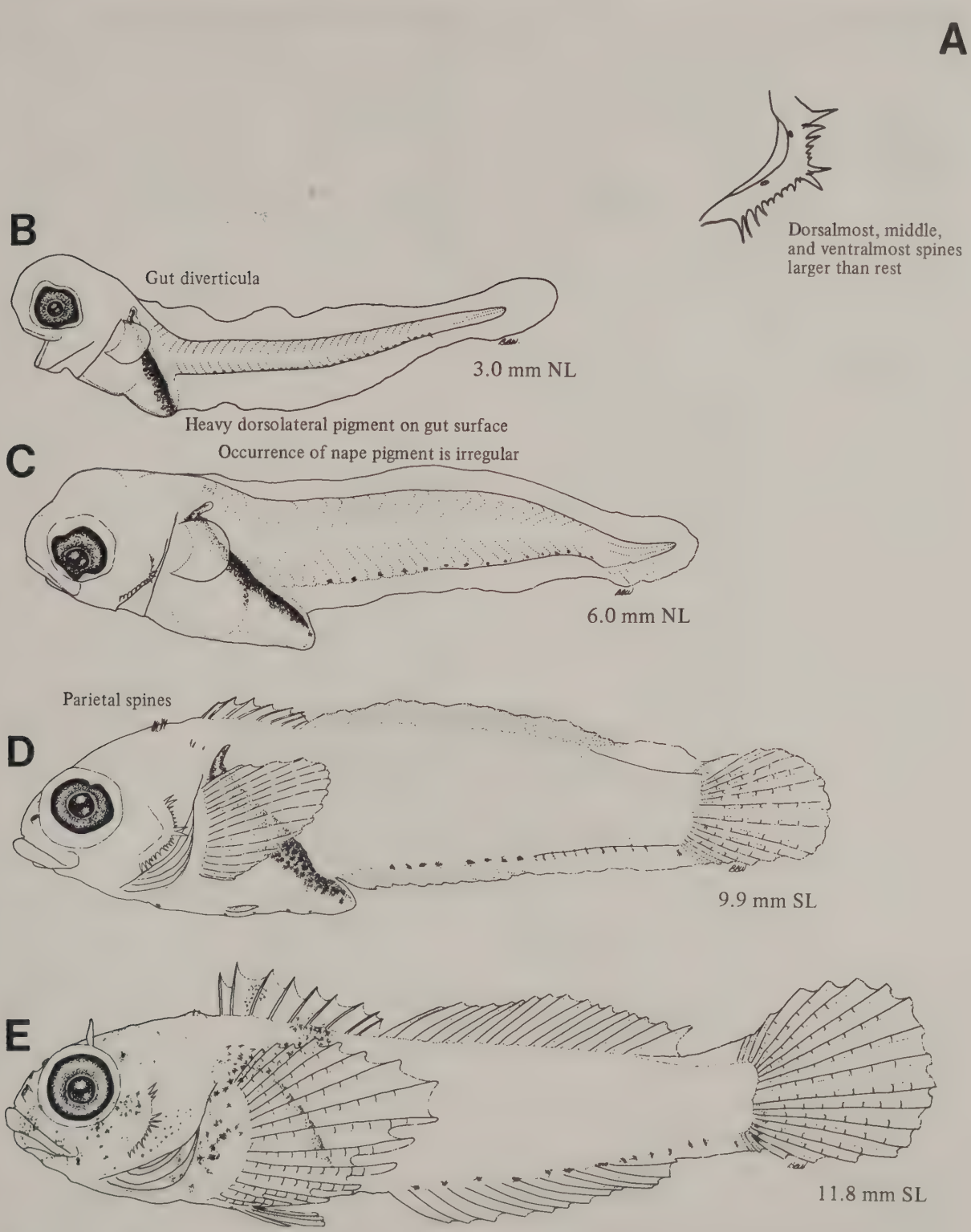



Figure A, Washington 1986; B–E, Richardson and Washington 1980.

# *Artedius harringtoni* (Starks 1896)

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 32-33-34 | |
| | Precaudal: 11-X-12 | |
| | Caudal: 22-X-23 | |
| **Branchiostegal rays** | 7-7-7 | |
| **Caudal fin** | X, 6+6, X | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 3-3-3 |
| **Dorsal fin** | S: 9-9-9 | R: 15-17-18 |
| **Pectoral fin** | R: 13-14-15 | |
| **Anal fin** | R: 10-13-14 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Aleutian Is., 51-55°N |
| **Ecology** | Nearshore shelf demersal, intertidal to 21 m |
| **ELH pattern** | Oviparous, eggs unknown, pelagic larvae |
| **Spawning** | Season: Possibly spring (California)[a] |
| | Area: |
| | Mode: Internal fertilization likely[b] |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous |
| **Envelope** | |
| **Hatch size** | <3 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | 5.2-6.4 mm NL |
| **Length at transformation** | ~13.6 mm SL (12-14 mm SL) |
| **Sequence of fin development** | Caudal, dorsal and anal rays, dorsal spines, pectorals, pelvics |

**Pigment** (see *A. fenestralis*, p. 414, footnote c)

- Lack of head pigment
- Presence of nape pigment
- 21-33 postanal ventral midline melanophores

**Diagnostic characters**

Distinguished from other *Artedius* spp. (*A. fenestralis*, *A. lateralis*, and *Artedius* 3) by

- Pigment (see above)
- Absence of gut diverticula
- Humped appearance in nape region
- Preopercular spines: 18-22 (late flexion, postflexion)
- Seven branchiostegal rays

[a] Burge and Schultz 1973
[b] NWAFC unpubl.

Ref: Richardson and Washington 1980; Washington 1981, 1986.

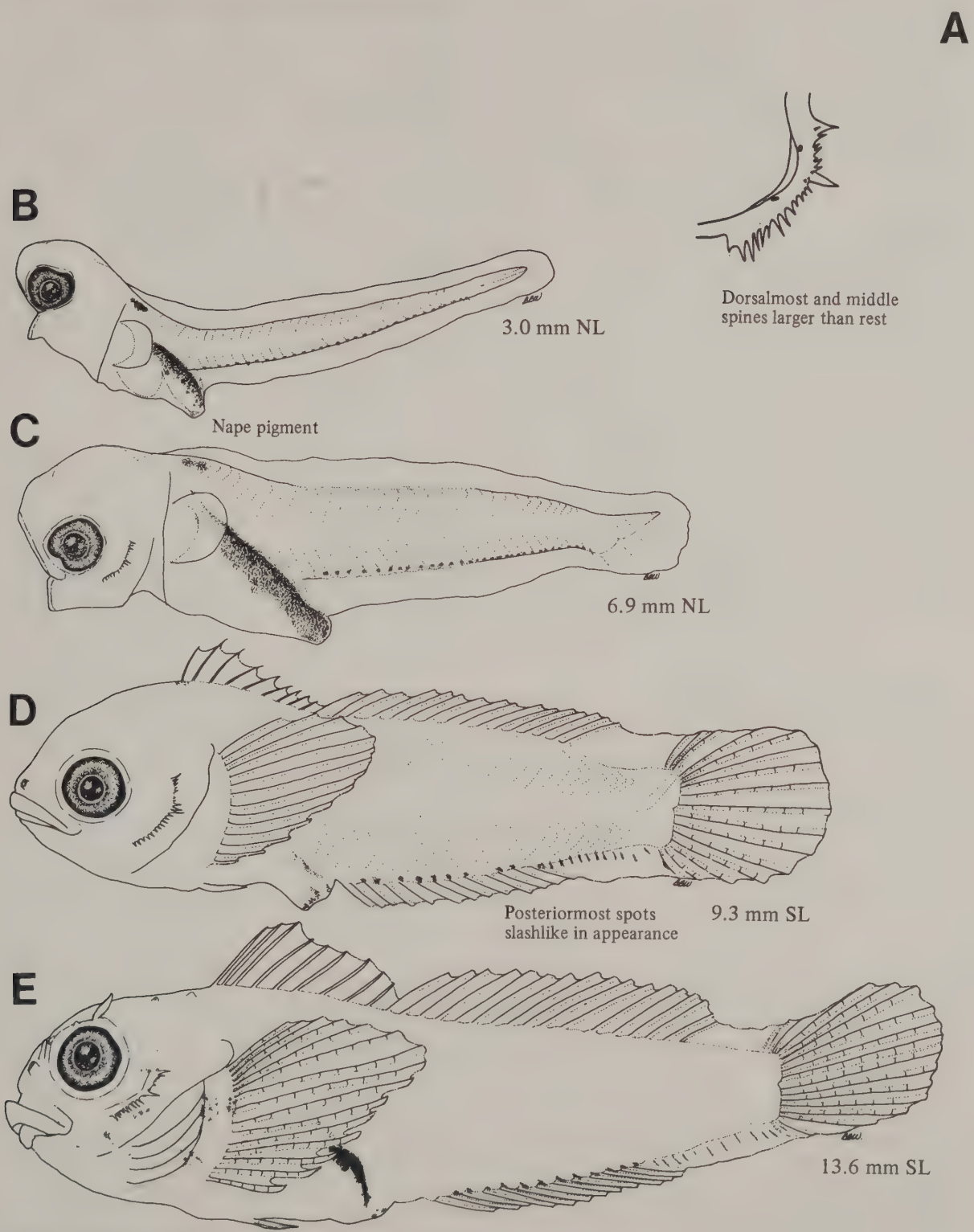



Figure A, Washington 1986; B–E, Richardson and Washington 1980.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 32-33-34 |
| | Precaudal: 11-11-11 |
| | Caudal: 21-22-23 |
| **Branchiostegal rays** | 6-6-6 |
| **Caudal fin** | X, 6+6, X |
| **Pelvic fin** | Thoracic |
| | S: 1-1-1 R: 3-3-3 |
| **Dorsal fin** | S: 7-9-10 R: 15-16-17 |
| **Pectoral fin** | R: 14-15-16 |
| **Anal fin** | R: 12-13-14 |
| **Gill rakers** | U: 1-X-2 L: 6-X-9 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Aleutian Is., 51-55°N |
| **Ecology** | Nearshore shelf demersal, intertidal to 13 m |
| **ELH pattern** | Oviparous; demersal, adhesive, attached eggs; pelagic larvae |
| **Spawning** | Season: Winter-spring (Brit. Col.);[a] June (Puget Sound)[b] |
| | Area: Demersal, on underside of rocks[a] |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 0.98-1.16 mm (1.07 mm) |
| **No. of oil globules** | One |
| **Oil globule diameter** | 0.22 mm |
| **Yolk** | Homogeneous; red, yellow, or orange |
| **Envelope** | Colorless, 0.031 mm thick |
| **Hatch size** | 3.9-4.5 mm SL (4.1 mm SL) |
| **Incubation time/temp.** | 16 d/15°C |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | 5.0-6.3 mm SL |
| **Length at transformation** | 8-10 mm SL |
| **Sequence of fin development** | Caudal, dorsal and anal rays, dorsal spines, pectorals, pelvics |

**Pigment** (see *A. fenestralis*, p. 414, footnote c)

- Lack of head and nape pigment is preflexion larvae
- Number (22-32) and size variation of postanal ventral midline melanophores
- Postflexion larvae have a marked increase in head pigment

**Diagnostic characters**

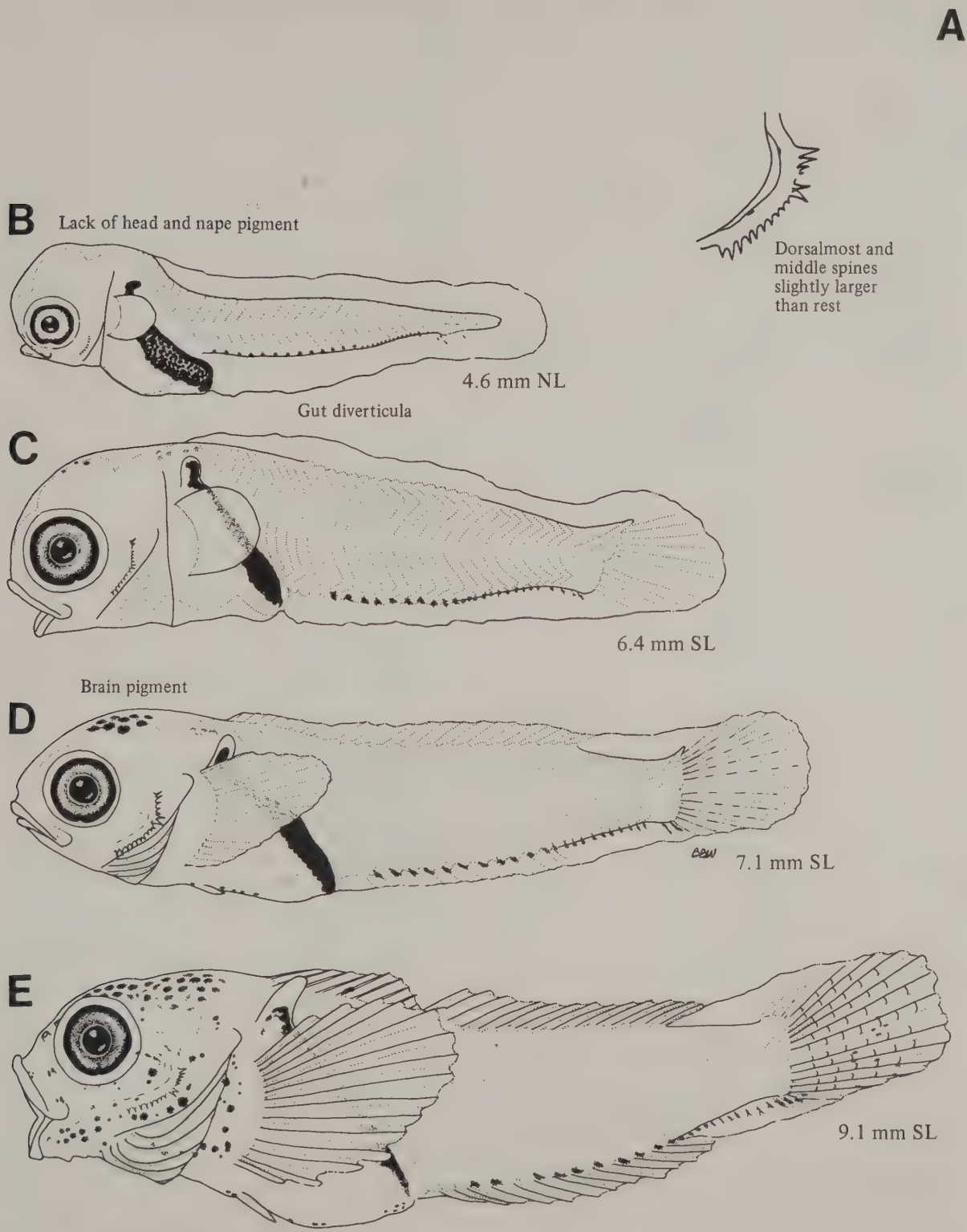
- Presence of gut diverticula
- Pigment (see above)

Distinguished from other *Artedius* spp. with gut diverticula (*A. fenestralis* and *Artedius* 3) by

- See *A. fenestralis*

[a] Marliave 1977
[b] NWAFC, unpubl.

Ref: Marliave 1975a; Richardson and Washington 1980; Washington 1981, 1986; Washington et al. 1984b.




Figures A–E, Washington 1986.

## MERISTICS *A. corallinus* (Hubbs 1926)

| | | |
|---|---|---|
| **Vertebrae** | Total: 31-32-33 | |
| | Precaudal: X-X-X | |
| | Caudal: 41-X-43 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | X, 6+6, X | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 3-3-3 |
| **Dorsal fin** | S: 8-9-9 | R: 15-16-16 |
| **Pectoral fin** | R: 14-15-16 | |
| **Anal fin** | R: 12-13-13 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## MERISTICS *A. notospilotus* Girard 1856

| | | |
|---|---|---|
| **Vertebrae** | Total: 32-33-34 | |
| | Precaudal: 12-12-12 | |
| | Caudal: 21-21-21 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | X, 6+6, X | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 3-3-3 |
| **Dorsal fin** | S: 9-9-10 | R: 14-15-16 |
| **Pectoral fin** | R: 14-16-17 | |
| **Anal fin** | R: 11-12-13 | |
| **Gill rakers** | U: 2-2-2 | L: 8-X-10 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Washington, 46-48°30′N |
| **Ecology** | Intertidal, nearshore shelf demersal |
| **ELH pattern** | Parity and eggs unknown, pelagic larvae |
| **Spawning** | Season:<br>Area:<br>Mode:<br>Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | ⩽2.9 mm NL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE (*Artedius* 3)[a]

| | |
|---|---|
| **Preanal length** | 45% SL |
| **Length at flexion** | 5.6-6.9 mm NL |
| **Length at transformation** | |
| **Sequence of fin development** | Caudal, dorsal and anal rays, dorsal spines and pectorals, pelvics |

**Pigment** (see *A. fenestralis*, p. 414, footnote c)

- Nape pigment
- 9-13 evenly spaced postanal ventral midline melanophores; begin about 3-4 myomeres posterior to anus

**Diagnostic characters**

Distinguished from other *Artedius* spp. with gut diverticula (*A. fenestralis* and *A. lateralis*) by

- Low number of postanal ventral midline melanophores in small larvae (9-13)
- Pigment: Lack of head pigment and presence of nape pigment
- Preopercular spines form earlier than other *Artedius* spp. (<4.1 mm NL)
- Number of preopercular spines higher than in other *Artedius* spp.

[a] *Artedius* 3 larvae are either *A. corallinus* or *A. notospilotus*. For a complete description see Washington (1986).

Ref: Washington 1986.

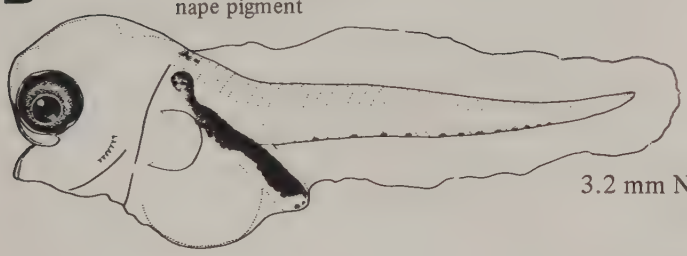
*Artedius* 3

A

*Artedius* type spine pattern: dorsalmost, middle, and ventralmost spines larger than rest

B

Gut diverticula and nape pigment



3.2 mm NL

C

9–13 evenly spaced postanal ventral melanophores

6.8 mm SL

D

7.3 mm SL

Figures A–D, Washington 1986.

# *Clinocottus acuticeps* (Gilbert 1895)

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 31-32-33 | |
| | Precaudal: 10-X-11[a] | |
| | Caudal: 21-22-23 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 3-3-3 |
| **Dorsal fin** | S: 7-8-9 | R: 13-15-17 |
| **Pectoral fin** | R: 13-14-15 | |
| **Anal fin** | R: 9-12-13 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Cent. California, 34-38°N, to Bering Sea, 54-66°N |
| **Ecology** | Intertidal, nearshore shelf demersal |
| **ELH pattern** | Oviparous, demersal eggs, pelagic larvae |
| **Spawning** | Season: Spring[b]<br>Area: Vertical rock surfaces under *Fucus* in upper intertidal zone (laid in monolayer)[b]<br>Mode: Internal fertilization likely[c]<br>Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.0-1.2 mm |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous; brown or purple |
| **Envelope** | |
| **Hatch size** | 3-4 mm NL (3.1-3.3 mm NL) |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | ~63% SL |
| **Length at flexion** | 5.5-7.3 mm NL |
| **Length at transformation** | 13-14 mm SL |
| **Sequence of fin development** | Caudal, dorsal and anal rays, dorsal spines, pectorals, pelvics |

**Pigment**

- Dorsal gut surface
- Relatively few (4-10) ventral midline melanophores

**Diagnostic characters**

Distinguished from all other cottids by

- Long gut with hindgut diverticula
- Flabby appearance
- Outer bubble of skin

[a] B.B. Washington, NMFS Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560, unpubl.
[b] Marliave 1981a
[c] Andriashev 1954

Ref: Blackburn 1973; Richardson and Washington 1980; Washington 1981, 1986; Washington et al. 1984b.

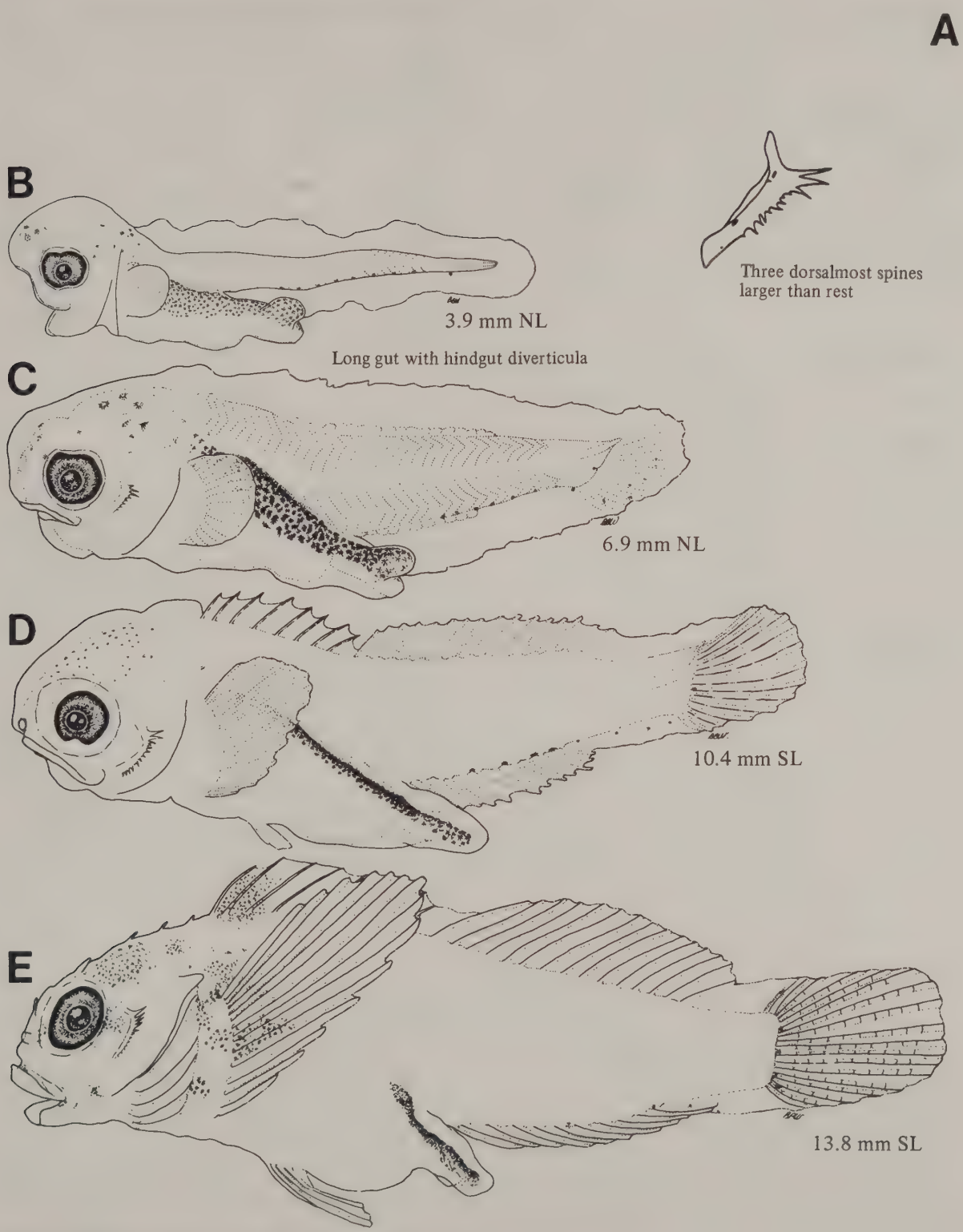



Figure A, Washington 1986; B–E, Richardson and Washington 1980.

# *Clinocottus embryum* (Jordan and Starks 1895)

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 33-33-34 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | X, 6+6, X | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 3-3-3 |
| **Dorsal fin** | S: 8-9-10 | R: 14-15-17 |
| **Pectoral fin** | R: 12-14-15 | |
| **Anal fin** | R: 9-10-12 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Bering Sea, 54-66°N |
| **Ecology** | Intertidal |
| **ELH pattern** | Oviparous, demersal eggs, pelagic larvae |
| **Spawning** | Season:<br>Area:<br>Mode: Internal fertilization likely[a]<br>Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous |
| **Envelope** | |
| **Hatch size** | ~4 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | 6.4-9.6 mm SL |
| **Length at transformation** | 13-14 mm SL |
| **Sequence of fin development** | Caudal, 2nd dorsal (rays) and anal, pectorals, 1st dorsal (spines), pelvics |

**Pigment**

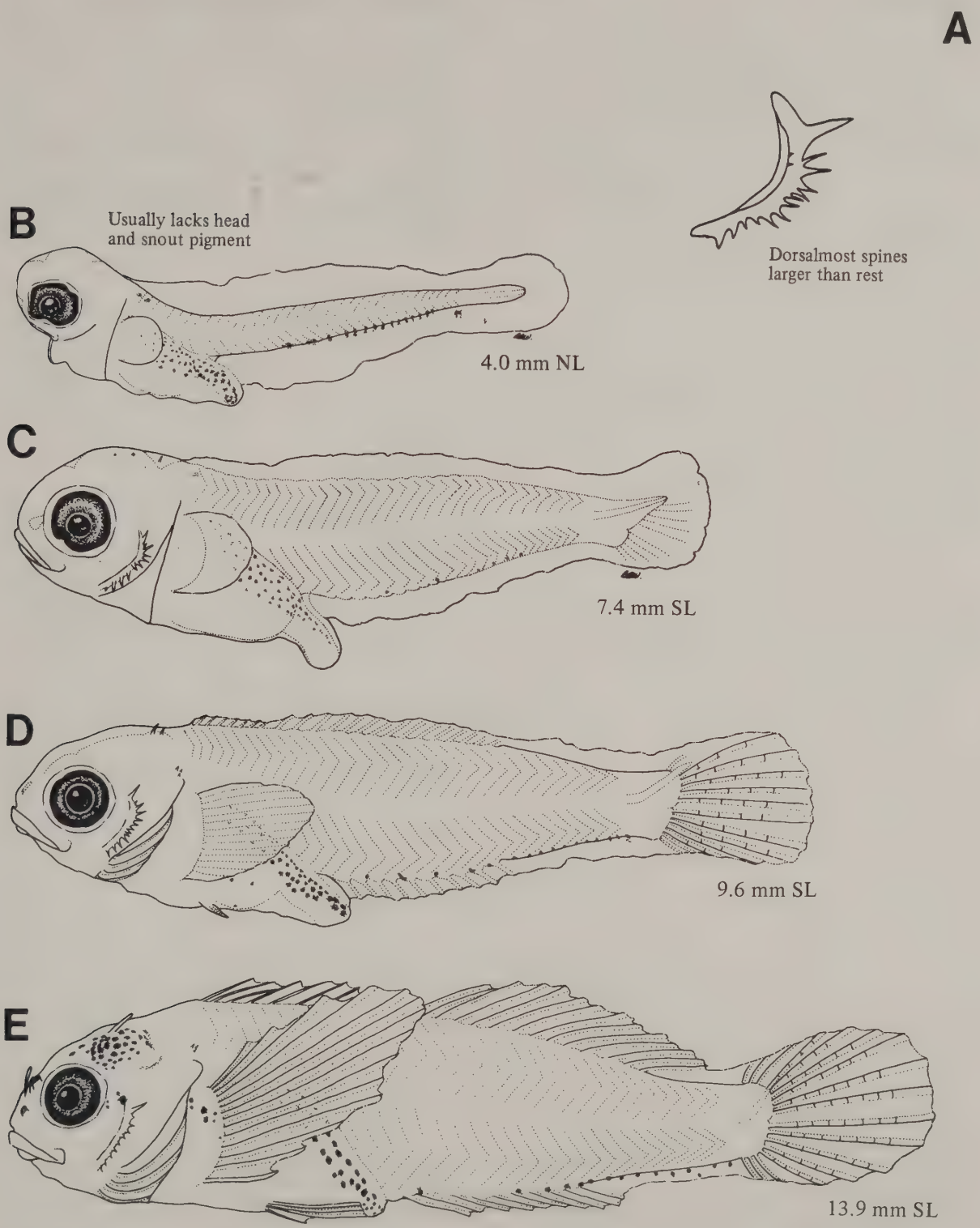
- Presence of head pigment is variable during development
- Light pigment on gut
- High number ventral midline melanophores (15-21)

**Diagnostic characters**

- Usually lacks head pigment; although variable, other *Clinocottus* spp. have head and snout pigment
- Long trailing gut
- Absence of hindgut diverticula
- 11-14 preopercular spines, tiny parietal spine

[a] Andriashev 1954

Ref: Richardson and Washington 1980 (see Cottidae 2); Washington 1981, 1986.




Figures A, D–E, Washington 1986; B–C, Richardson and Washington 1980.

# *Clinocottus globiceps* (Girard 1858)

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 32-33-34 | |
| | Precaudal: 11-12-12 | |
| | Caudal: 20-21-23 | |
| **Branchiostegal rays** | 6-6-6 (occasionally 7) | |
| **Caudal fin** | X, 6+6, X | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 3-3-3 |
| **Dorsal fin** | S: 8-9-10 | R: 13-16-17 |
| **Pectoral fin** | R: 13-14-15 | |
| **Anal fin** | R: 11-11-12 | |
| **Gill rakers** | U: 1-1-1 | L: 5-5-5 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Gulf of Alaska, 54-60°N |
| **Ecology** | Intertidal |
| **ELH pattern** | Oviparous, demersal eggs, pelagic larvae |
| **Spawning** | Season:<br>Area:<br>Mode: Internal fertilization likely[a]<br>Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.5-2.0 mm |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous |
| **Envelope** | |
| **Hatch size** | 5.1-5.4 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | 6.2-~8.1 mm SL |
| **Length at transformation** | 12.9-13.5 mm SL |
| **Sequence of fin development** | Caudal; dorsal, anal, and pectorals; pelvics |

**Pigment**

- Heavy on head, nape, dorsolateral surface of gut
- Ventral midline melanophores along posteriormost 10 myomeres

**Diagnostic characters**

- Late flexion: 15-20 preopercular spines and a cluster of spines in parietal region

Distinguished from other preflexion *Clinocottus* spp. by

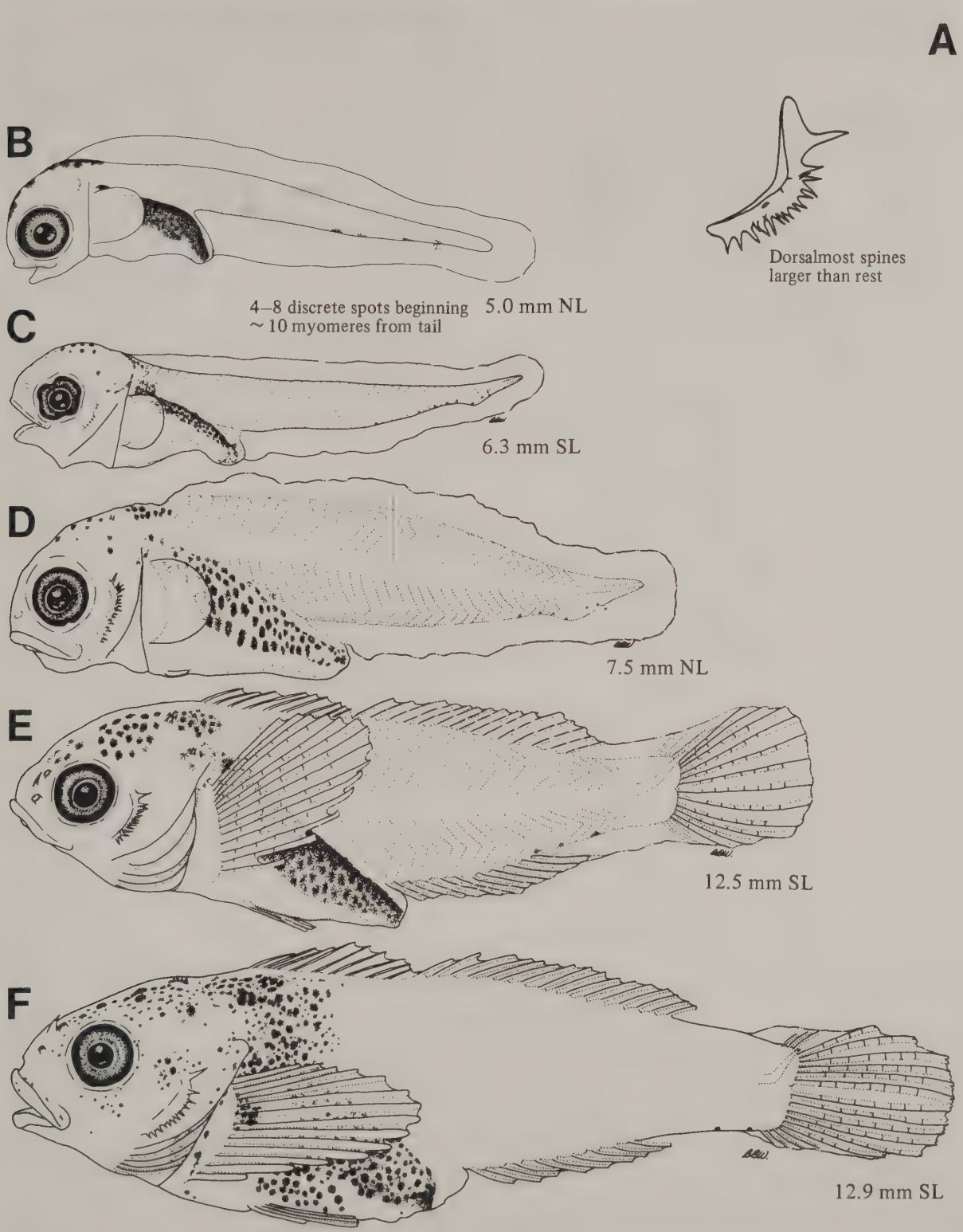
- Heavy pigment on head, nape, and gut

Distinguished from *C. recalvus* by

- 4-8 ventral midline melanophores

[a] Andriashev 1954

Ref: Richardson and Washington 1980 (see Cottidae 3); Washington 1981, 1986; Washington et al. 1984b.




Figures A–B, F, Washington 1986; C–E, Richardson and Washington 1980.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 32-33-33 | |
| | Precaudal: 10-11-12 | |
| | Caudal: 20-22-23 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | X, 6+6, X | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 3-3-3 |
| **Dorsal fin** | S: 8-9-9 | R: 14-16-16 |
| **Pectoral fin** | R: 13-14-15 | |
| **Anal fin** | R: 9-12-13 | |
| **Gill rakers** | U: 1-1-1 | L: 4-X-7 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Oregon, 42-46°N |
| **Ecology** | Intertidal, nearshore shelf demersal |
| **ELH pattern** | Oviparous, demersal eggs, pelagic larvae |
| **Spawning** | Season:<br>Area:<br>Mode: Internal fertilization likely,[a] males guard nests[b]<br>Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.25-1.35 mm (1.3 mm) |
| **No. of oil globules** | Several |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous |
| **Envelope** | |
| **Hatch size** | ~4.6 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | |
| **Length at flexion** | |
| **Length at transformation** | 9-11 mm SL |
| **Sequence of fin development** | |

**Pigment**

- Heavy on dorsolateral surface of gut
- Series of ventral midline melanophores extending into finfold
- Heavy pigment on snout, crown, and nape

**Diagnostic characters**

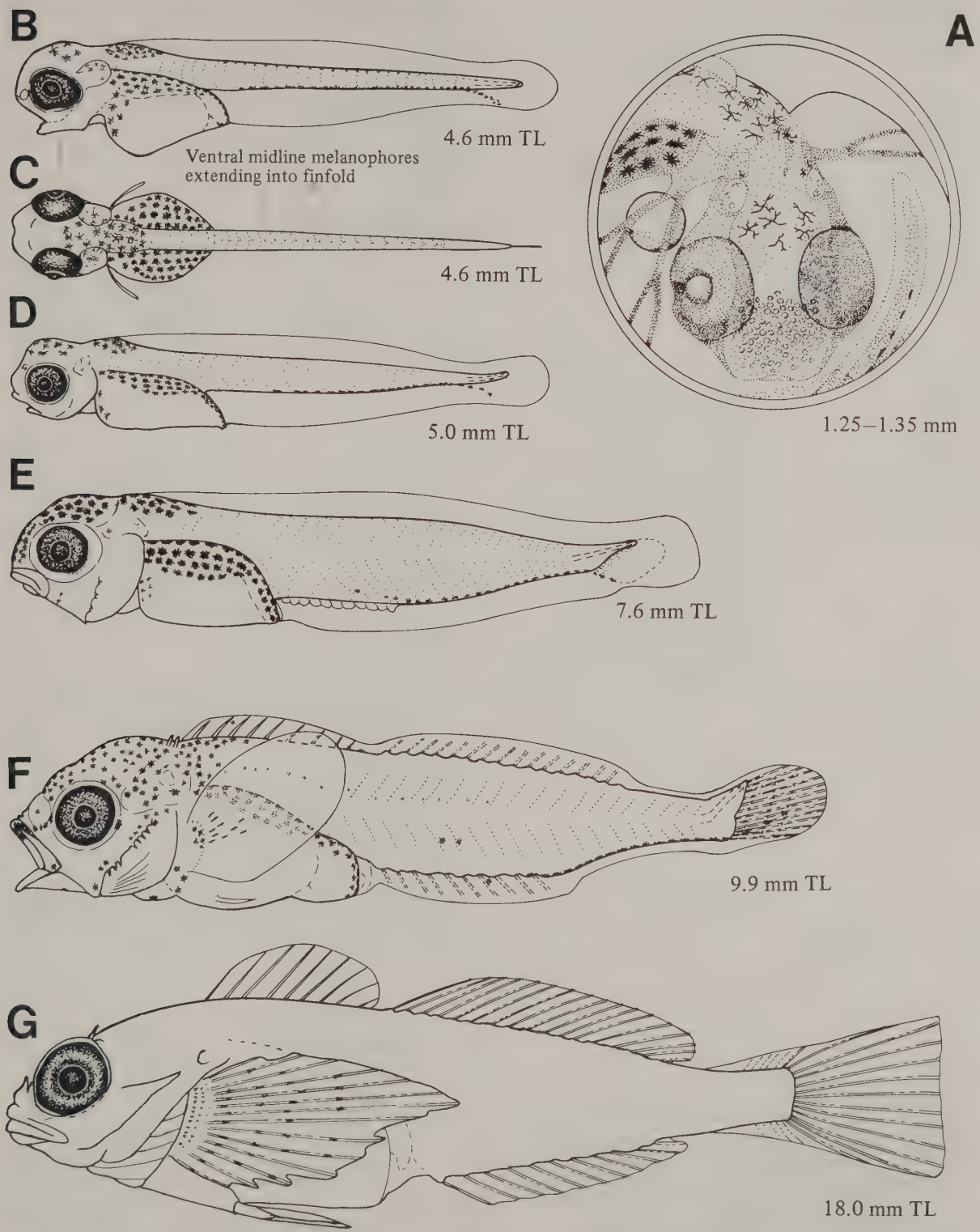
- Multiple preopercular spines

Distinguished from other *Clinocottus* spp. by

- Minimal trailing of hindgut

[a] Andriashev 1954
[b] Morris 1951.

Ref: Morris 1951.




Figures A–G (C, dorsal view), Morris 1951 (B–G, redrawn). Redrawn figures are based only on distribution of melanophores. Other pigment cells shown on the original figures are deleted.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 33-34-34 | |
| | Precaudal: 11-12-12 | |
| | Caudal: 21-22-23 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 3-3-3 |
| **Dorsal fin** | S: 8-8-9 | R: 15-17-18 |
| **Pectoral fin** | R: 12-14-15 | |
| **Anal fin** | R: 12-13-14 | |
| **Gill rakers** | U: 1-1-1 | L: 4-X-5 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Bering Sea, 54-66°N |
| **Ecology** | Intertidal |
| **ELH pattern** | Oviparous; demersal, adhesive eggs; pelagic larvae |
| **Spawning** | Season: Apr-July (Puget Sound)[a]<br>Area: Intertidal, between rocks, barnacles, or bay mussels (not attached to substrate)[b]<br>Mode: Internal fertilization, multiple spawning (three)[a] |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | 1 yr[a] |
| **Longevity** | |

[a] Atkinson 1939

[b] J. Marliave, Vancouver Public Aquarium, P.O. Box 3232, Vancouver, B.C., Canada V6B 3X8, pers. commun., 25 Oct. 1988.

[c] Specimens reared in the laboratory have shown a high degree of variability in pigmentation. Postanal ventral melanophores range from 10 to >50. Other characters appear to vary between geographical area, e.g., presence of ventral or lateral gut pigment and the nape bubble (J. Marliave, pers. commun., 25 Oct. 1988).

Ref: Stein 1973; Washington 1981, 1986; Washington et al. 1984b.

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.3-1.5 mm |
| **No. of oil globules** | One large, many small |
| **Oil globule diameter** | |
| **Yolk** | Green, brown, or red[b] |
| **Envelope** | |
| **Hatch size** | 4.2-4.5 mm NL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 37% SL, increasing with development to 48% SL |
| **Length at flexion** | 7.2-7.6 mm SL |
| **Length at transformation** | 7.5-10.0 mm SL |
| **Sequence of fin development** | Caudal, dorsal and anal rays, dorsal spines, pectorals, pelvics |

**Pigment**[c]

- Head and nape
- Dorsolateral surface of gut
- Postanal ventral midline series, with development becoming more closely spaced posteriorly

**Diagnostic characters**

- Bubble of skin anterior to origin of dorsal finfold

Distinguished from *O. snyderi* by

- Ventral midline melanophores (>15)
- Bubble of skin pigmented

Eggs and larvae of *O. rimensis* are unknown. The following information will aid in identification.

| | |
|---|---|
| Total vertebrae | 34-37 |
| Precaudal | 11-13 |
| Caudal | 22-25 |
| Dorsal fin spines | 8-10 |
| Dorsal fin rays | 16-19 |
| Anal fin rays | 13-15 |
| Pectoral fin rays | 13-15 |
| Pelvic fin rays | 3 |
| Range | SSC-SE Alaska |

A

Dorsalmost spine larger than rest

B

Bump similar to *Artedius* but does not develop into a distinct diverticula

4.3 mm NL

C

6.9 mm NL

D

7.8 mm SL

Figures A–D, Washington 1986 (B–D, reared).

# *Oligocottus snyderi* Greeley 1898

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 34-35-37 | |
| | Precaudal: 10-11-12 | |
| | Caudal: 23-24-25 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 3-3-3 |
| **Dorsal fin** | S: 7-8-9 | R: 17-19-20 |
| **Pectoral fin** | R: 12-14-15 | |
| **Anal fin** | R: 12-14-15 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to SE Alaska, 55-59°N |
| **Ecology** | Intertidal, nearshore shelf demersal |
| **ELH pattern** | Oviparous, demersal eggs, pelagic larvae |
| **Spawning** | Season: Winter-spring; fall in more northerly populations[a]<br>Area:<br>Mode: Internal fertilization (spawn twice/season)[a]<br>Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | <1 yr[a] |
| **Longevity** | >2 yr[a] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.2-1.3 mm |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | 4.47 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <45% SL |
| **Length at flexion** | 6.2-8.4 mm SL |
| **Length at transformation** | 11-13 mm SL |
| **Sequence of fin development** | Caudal, dorsal and anal rays, dorsal spines, pectorals, pelvics |

**Pigment**

- Head and nape very lightly pigmented
- Dorsolateral surface of gut
- Ventral midline series with <10 evenly spaced melanophores

**Diagnostic characters**

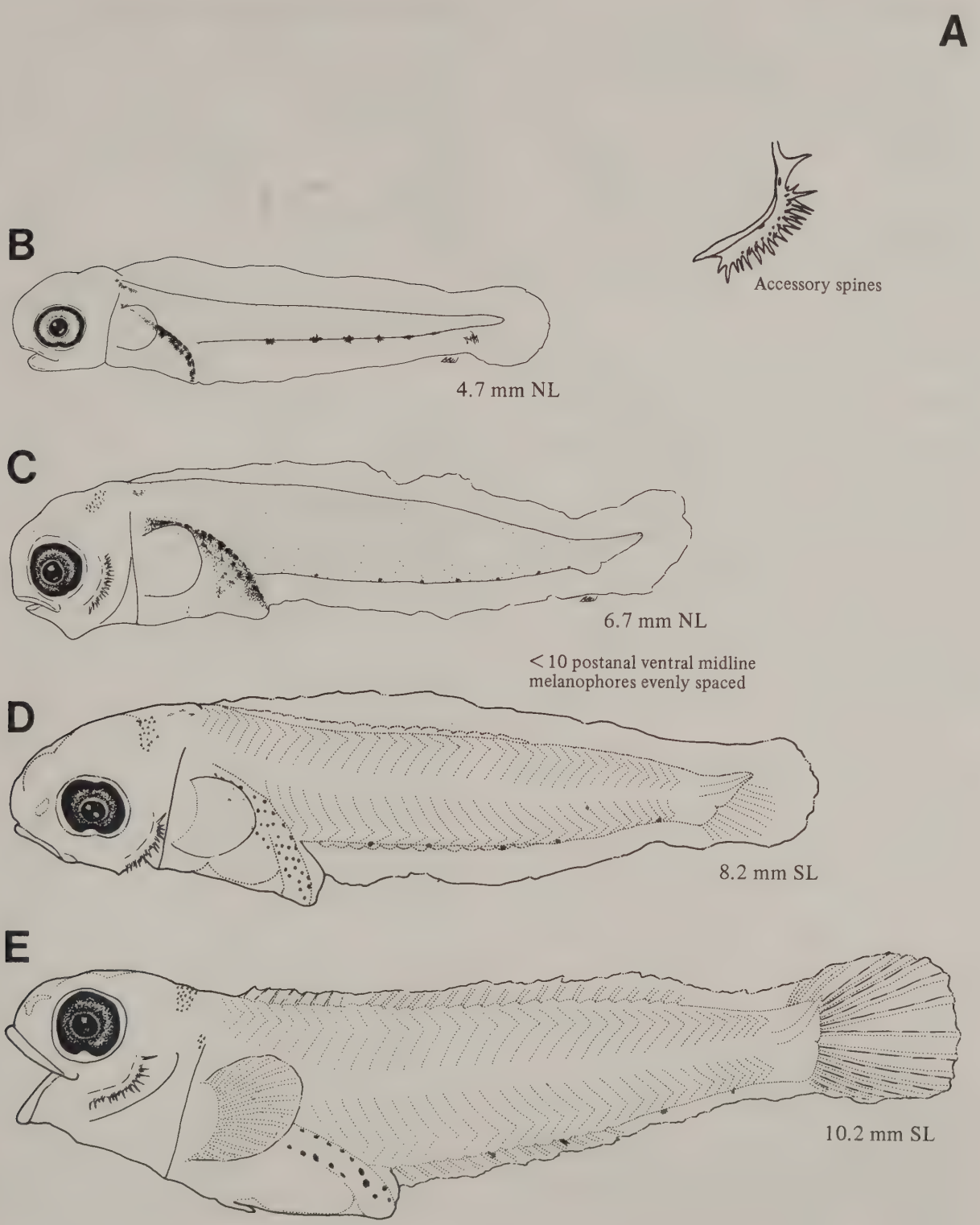
- Spines
  - —Patch of parietal spines
  - —10-12 spines develop along preopercular margin
  - —8-10 accessory spines form anteriorly at the bases of the preopercular spines

Distinguished from *O. maculosus* by

- Bubble of skin anterior to origin of dorsal finfold unpigmented and less obvious than *O. maculosus*
- Ventral midline melanophores (<10)

[a] Grossman and DeVlaming 1984

Ref: Richardson and Washington 1980 (see Cottidae 1); Stein 1973; Washington 1981, 1986; Washington et al. 1984b.




Figures A–B, D–E, Washington 1986; C, Richardson and Washington 1980 (B–C, reared).

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 33-34-35 | |
| | Precaudal: 13-13-13[a] | |
| | Caudal: 20-20-20[a] | |
| **Branchiostegal rays** | 7-7-7 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 3-3-3 |
| **Dorsal fin** | S: 7-X-8 | R: 18-X-19 |
| **Pectoral fin** | R: 14-16-17 | |
| **Anal fin** | R: 12-14-15 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Washington, 46-48°30′N, to Bering Sea, 54-66°N |
| **Ecology** | Epi- and mesobenthal, 0-225 m |
| **ELH pattern** | Oviparous, demersal eggs, pelagic larvae |
| **Spawning** | Season: Aug (British Columbia)[b] |
| | Area: Rocky subtidal areas on solid substrate[b] |
| | Mode: Polygamous males guard nest[c] |
| | Migration: |
| **Fecundity** | Range/function: $\bar{x}$ 130[b] |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | ~2.3 mm |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous; pink |
| **Envelope** | White |
| **Hatch size** | ~6-7 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | |
| **Length at flexion** | |
| **Length at transformation** | 18-20 mm SL (settle)[d] |
| **Sequence of fin development** | |

**Pigment** (*Psychrolutes* Group)

- Head, nape, gut, and pectoral fins
- Lacks postanal ventral melanophores

**Diagnostic characters**

- Morphology
  - —Tadpole shape
  - —Large head
  - —Outer layer of loose flabby skin
- Large pigmented pectoral fins
- No head or preopercular spines

Distinguished from *Psychrolutes paradoxus* (p. 436) by

- Pectoral fin ray count (14-17)
- Less body pigment

[a] B.B. Washington, NMFS Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560, unpubl.
[b] Marliave 1975a
[c] J. Marliave, Vancouver Public Aquarium, P.O. Box 3232, Vancouver, B.C., Canada V6B 3X8, pers. commun., 16 Oct. 1986.
[d] Juveniles have a tendency to reenter the water column for feeding, producing a protracted period of ambivalence about settlement (Marliave 1981b).

Ref: Marliave 1975a, Washington et al. 1984b.

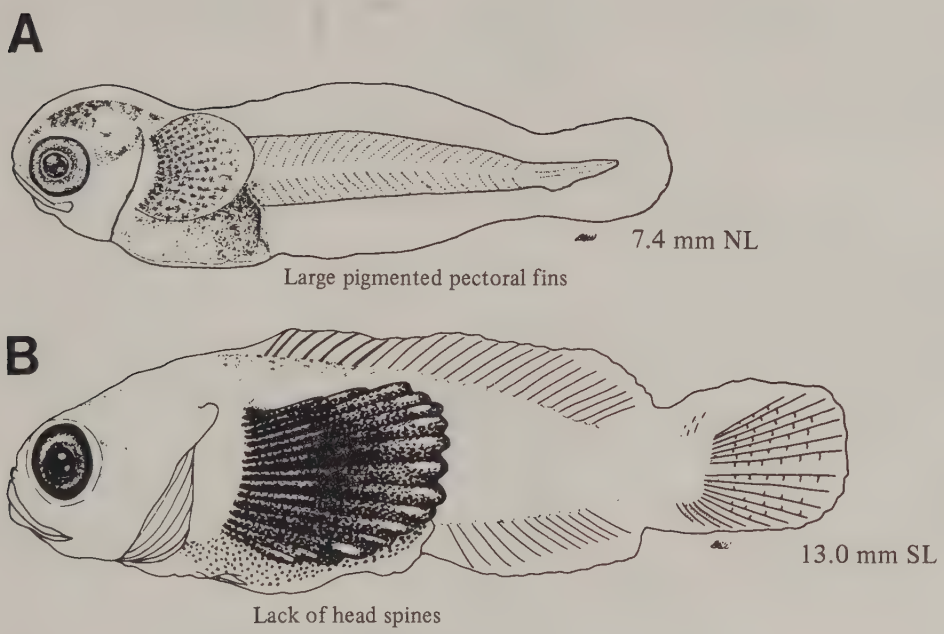



Figure A, Richardson and Bond 1978; B, Richardson 1981a.

# *Psychrolutes paradoxus* Günther 1861

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 36-36-37 | |
| | Precaudal: 11-11-11[a] | |
| | Caudal: 21-21-21[a] | |
| **Branchiostegal rays** | 7-7-7 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 3-3-3 |
| **Dorsal fin** | S: 9-11-12 | R: 12-14-17 |
| **Pectoral fin** | R: 19-21-23 | |
| **Anal fin** | R: 10-12-14 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Washington, 46-48°30′N, to Bering Sea, 54-66°N |
| **Ecology** | Epi- and mesobenthal, 9-219 m |
| **ELH pattern** | Oviparous, demersal eggs, pelagic larvae |
| **Spawning** | Season: Winter-spring (British Columbia)[b] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

[a] B.B. Washington, NMFS Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560, unpubl.
[b] Marliave 1975a

Ref: Blackburn 1973, Marliave 1975a.

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | ~1.4 mm |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous |
| **Envelope** | |
| **Hatch size** | ~6-7 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | |
| **Length at flexion** | |
| **Length at transformation** | ~13-14 mm SL |
| **Sequence of fin development** | |

**Pigment**

- Initially restricted to head, gut, and upper body (including pectoral fins); with development, increasing to 3/4 body

**Diagnostic characters**

- Morphology
  - —Tadpole shape
  - —Large head
  - —Outer layer of loose flabby skin
- Large pigmented pectoral fins
- No head or preopercular spines

Distinguished from *Gilbertidia sigalutes* (p. 434) by

- More lateral pigment on head and body with development
- Pectoral fin ray count (19-23)

Eggs and larvae of *P. phrictus* are unknown (see Cottoid A, p. 438). The following information will aid in identification.

| | |
|---|---|
| Total vertebrae | 33-35 |
| Dorsal fin spines | 8-9 |
| Dorsal fin rays | 19-20 |
| Anal fin rays | 12-14 |
| Pectoral fin rays | 22-26 |
| Pelvic fin rays | 3 |
| Range | Cent. Calif.-Bering Sea |

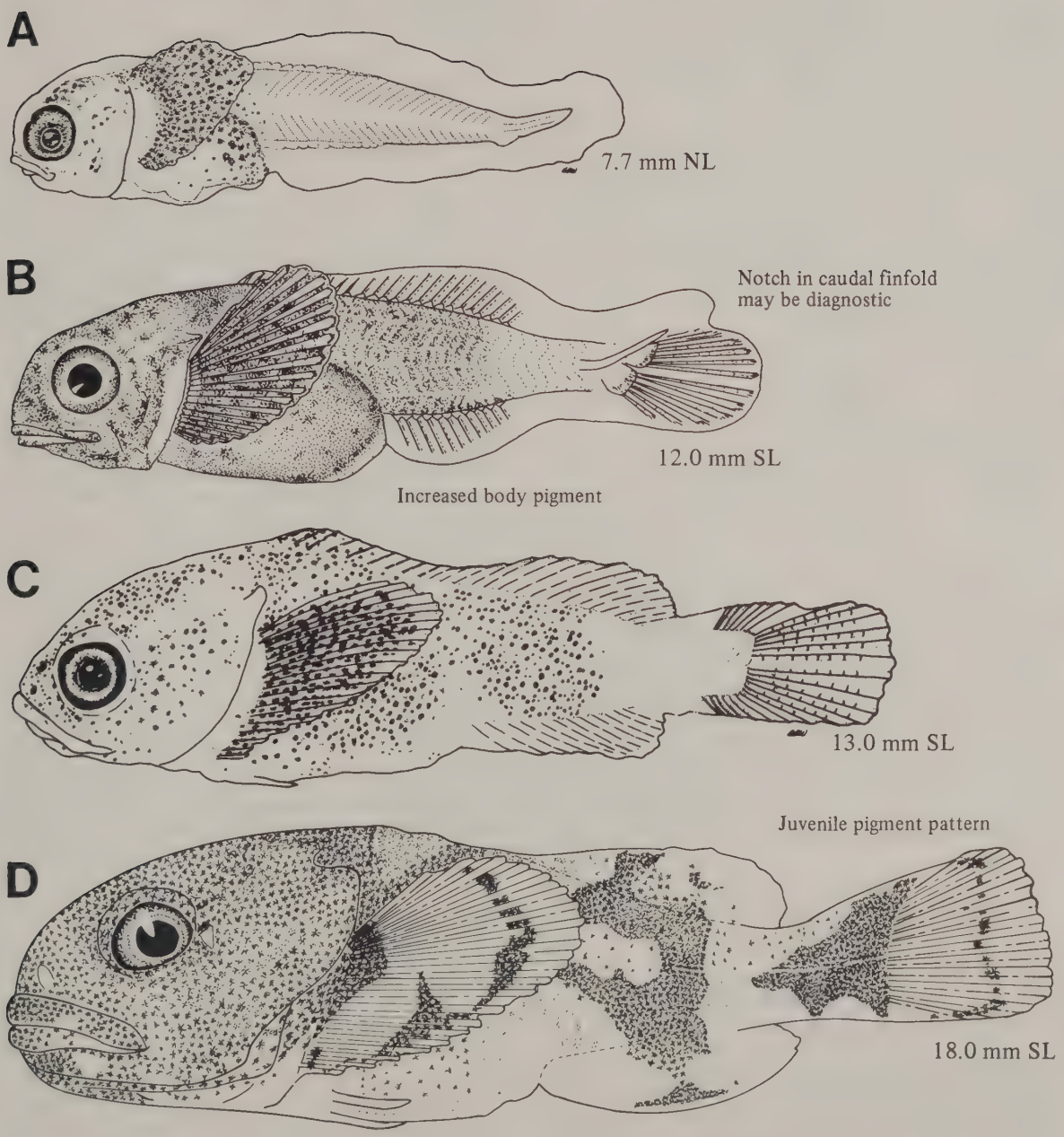



Figure A, Richardson and Bond 1978; B, Marliave 1975a (redrawing provided by Marliave); C, Richardson 1981a; D, NWAFC original (B. Vinter).

# Cottoid A (Richardson and Washington 1980)[a]

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 35-35-35 | |
| | Precaudal: 12-12-12 | |
| | Caudal: 23-23-23 | |
| **Branchiostegal rays** | 7-7-7 | |
| **Caudal fin** | X, 6+7, X | |
| **Pelvic fin** | Abdominal | |
| | S: 1-1-1 | R: 3-3-3 |
| **Dorsal fin** | S: 8-8-8 | R: 20-20-20 |
| **Pectoral fin** | R: 26-26-26 | |
| **Anal fin** | R: 14-14-14 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Oregon, 42-46°N |
| **Ecology** | Unknown |
| **ELH pattern** | Parity and eggs unknown, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE[b]

| | |
|---|---|
| **Preanal length** | 58% SL, increasing with development to 79% SL |
| **Length at flexion** | ~9.8 mm SL |
| **Length at transformation** | >13.4 mm SL |
| **Sequence of fin development** | |

**Pigment**

- Larvae are pigmented over entire body except at the tail tip; dorsal and anal finfolds and the distal portion of the pectoral fin are unpigmented

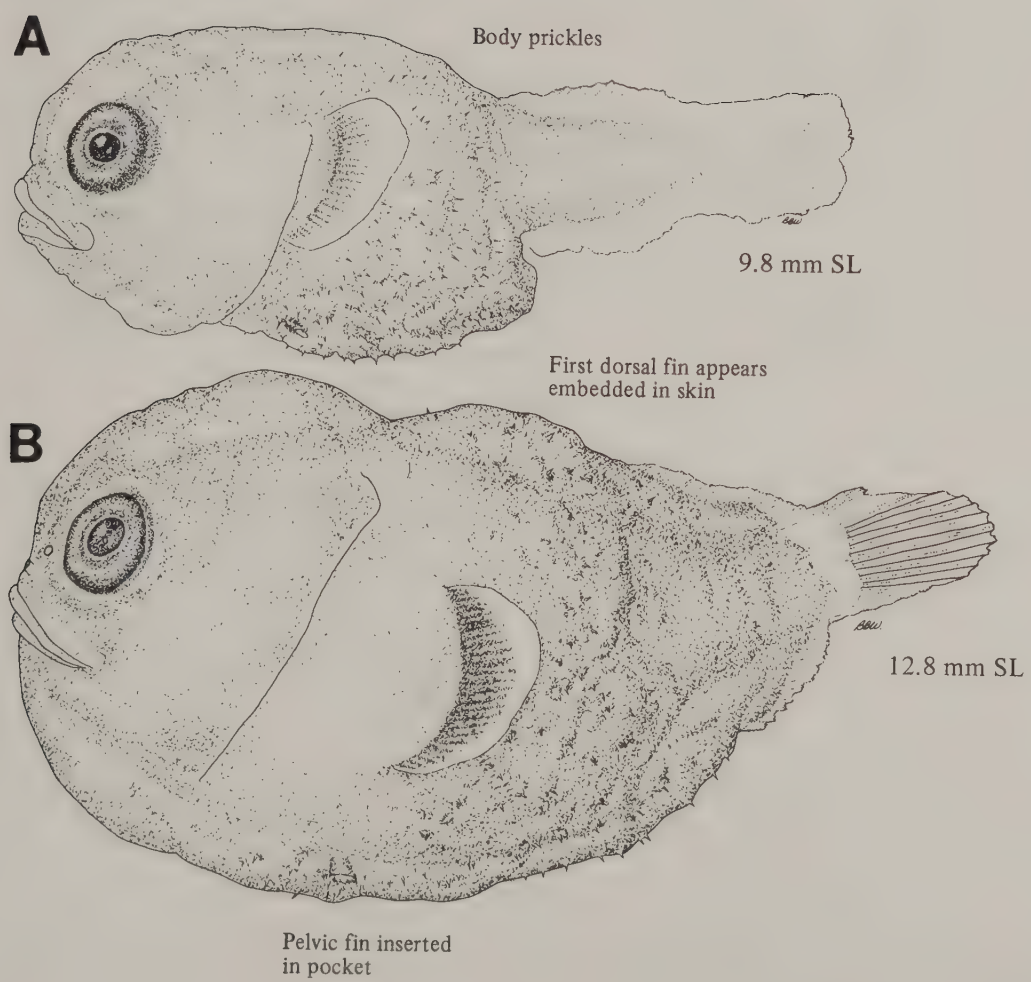
**Diagnostic characters**

- Lack of head spines
- Prickles over body
- Globose morphology unlike any other cottid
- Loose outer skin
- Pelvic fin appears to be inserted in pockets of skin with only the tips exposed

Meristic characters of Cottoid A specimens agree with those of *Psychrolutes phrictus* (pectoral rays = 26, branchiostegals = 7), but identification is tentative until additional material is available (see discussion in Richardson and Washington [1980]).

[a] Based on three specimens (9.8, 12.8, 13.4 mm SL) collected off Oregon.
[b] Tentative placement in *Psychrolutes* group.

Ref: Richardson and Washington 1980.




Figures A–B, Richardson and Washington 1980.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 34-35-35 | |
| | Precaudal: 10-X-13[a] | |
| | Caudal: 23[b]-X-26 | |
| **Branchiostegal rays** | 7-7-7 | |
| **Caudal fin** | X, 6+6, X | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 3-3-3 |
| **Dorsal fin** | S: 8-10-11 | R: 13-15-16 |
| **Pectoral fin** | R: 22-25-26 | |
| **Anal fin** | R: 12-14-16 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Washington, 46-48°30′N, to Bering Sea, 54-66°N |
| **Ecology** | Epi-, meso-, and bathybenthal, 18-825 m |
| **ELH pattern** | Parity unknown, eggs probably demersal, pelagic larvae |
| **Spawning** | Season:<br>Area:<br>Mode:<br>Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous |
| **Envelope** | |
| **Hatch size** | ~7.4 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | |
| **Length at transformation** | |
| **Sequence of fin development** | Fins complete at 12 mm SL |

**Pigment**

- Heavy spots on head and gut
- Double row of small pigment spots occurs along the midline of the ventral surface of gut; more pronounced in specimens >8 mm SL
- Pectoral fin pigmented at base

**Diagnostic characters**

- Similar to *Psychrolutes* group but with four preopercular spines

[a] One specimen with precaudal vertebrae = 13 (B.B. Washington, NMFS Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560, unpubl.).
[b] B.B. Washington, unpubl.

Ref: Blackburn 1973.

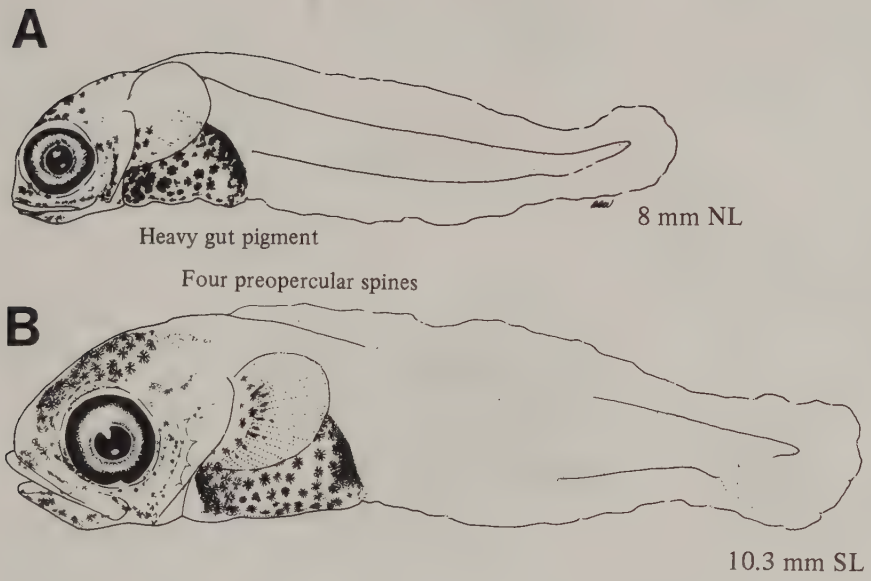



Figure A, Richardson 1981a; B, Washington et al. 1984a.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 30-32-33 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 7-7-7 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 3-3-3 |
| **Dorsal fin** | S: 8-9-9 | R: 12-14-15 |
| **Pectoral fin** | R: 19-20-23 | |
| **Anal fin** | R: 9-11-12 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Washington, 46-48°30′N, to Bering Sea, 54-66°N |
| **Ecology** | Epi-, meso-, and bathybenthal, 75-1980 m |
| **ELH pattern** | Parity and eggs unknown, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

**Preanal length**
**Length at flexion**
**Length at transformation**
**Sequence of fin development**
**Pigment**

- Head, nape, entire gut
- Laterally over 1/4 body, with development increasing to 3/4 body

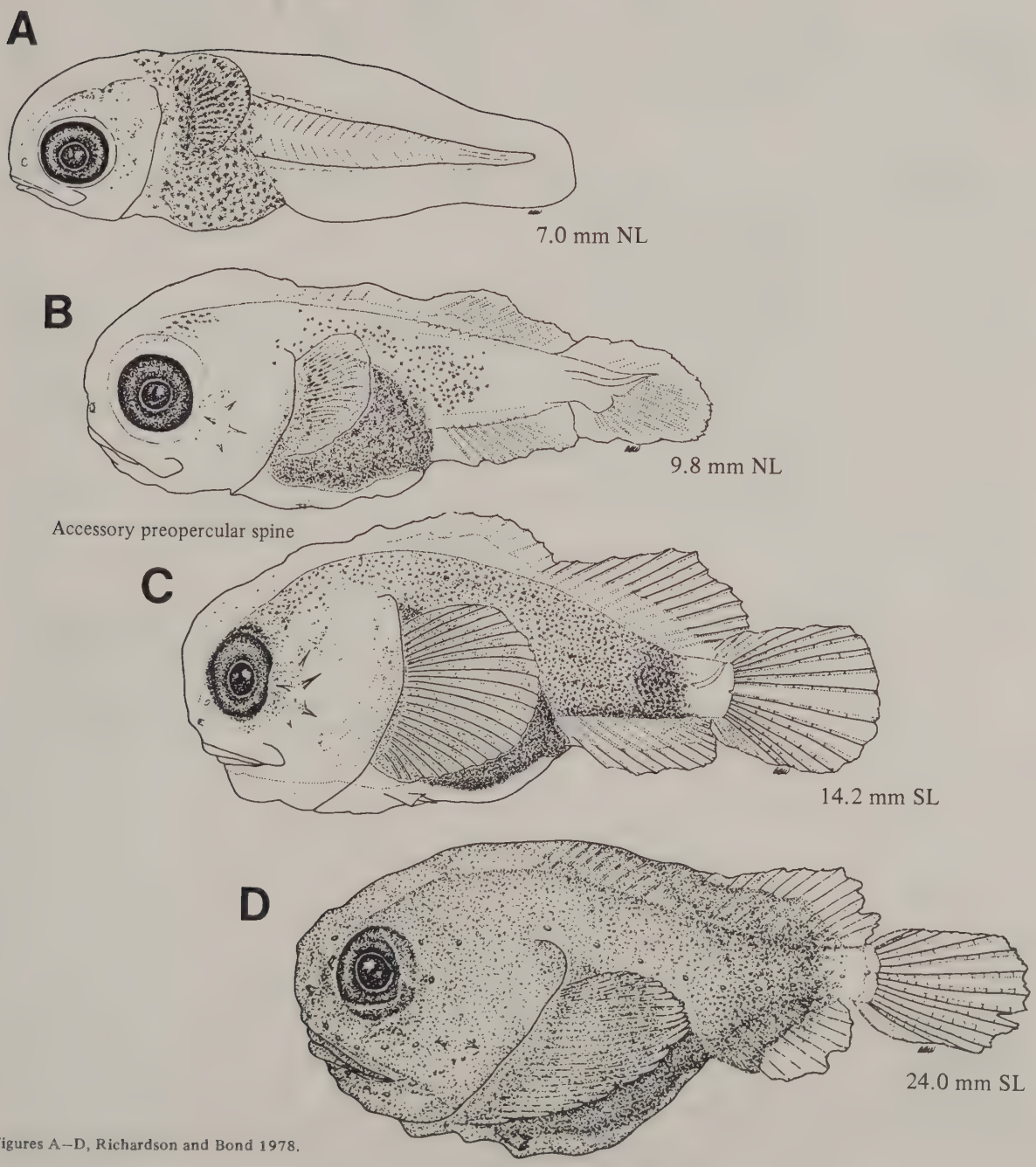
**Diagnostic characters**

- Fifth accessory preopercular spine (sometimes difficult to see)
- Outer layer of loose skin more pronounced than in other genera (genus)

Eggs and larvae of *M. kincaidi* are unknown. The following information may aid in identification.

| | |
|---|---|
| Total vertebrae | 31-33 |
| Dorsal fin spines | 8-10 |
| Dorsal fin rays | 13-15 |
| Anal fin rays | 10-13 |
| Pectoral fin rays | 19-21 |

Ref: Richardson and Bond 1978.




Figures A–D, Richardson and Bond 1978.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 34-37-39 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | X, 6+6, X | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 4-4-4 |
| **Dorsal fin** | S: 7-9-11 | R: 18-20-21 |
| **Pectoral fin** | R: 14-15-17 | |
| **Anal fin** | R: 14-17-18 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Gulf of Alaska, 54-60°N |
| **Ecology** | FW or anadromous type |
| **ELH pattern** | Oviparous; demersal, adhesive eggs; pelagic larvae |
| **Spawning** | Season: Jan-Apr;[a] Feb-July[b]<br>Area: Under rocks[b]<br>Mode: Polygamous males, eggs guarded[b]<br>Migration: Downstream in spring to spawn[b] |
| **Fecundity** | Range/function: 280-10,980[a] |
| **Age at first maturity** | |
| **Longevity** | >7 yr[b] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.4-1.6 mm |
| **No. of oil globules** | One large, some small |
| **Oil globule diameter** | 0.2-0.3 mm |
| **Yolk** | Homogeneous; granular[a] |
| **Envelope** | Thick, transparent, orange |
| **Hatch size** | 4.5-5.0 mm SL;[a]<br>5.5-6.3 mm SL[c] |
| **Incubation time/temp.** | 15-16 d/12°C |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 40% SL |
| **Length at flexion** | ~7 mm SL |
| **Length at transformation** | 10 mm SL |
| **Sequence of fin development** | Pectorals and pelvics by 10 mm SL |

**Pigment**

- Dorsal and ventral gut surface
- Postanal ventral midline series decreasing in number and becoming more evenly spaced with development

**Diagnostic characters**

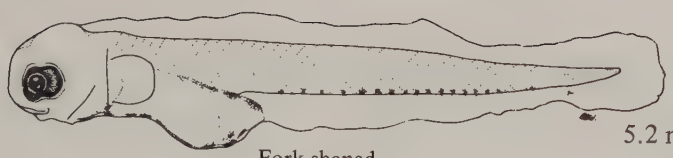
- Morphology: Slender, round snout
- Spines: Four preopercular, without other head spines
- Gut shape unique, posteriorly forked

Larvae of *C. aleuticus* are unknown. Spawning takes place primarily in freshwater and larvae may not occur in coastal marine plankton.

[a] Wang 1981
[b] Morrow 1980
[c] Richardson and Washington 1980

Ref: Morrow 1980, Stein 1972, Richardson and Washington 1980, Wang 1981, Washington et al. 1984b.

A



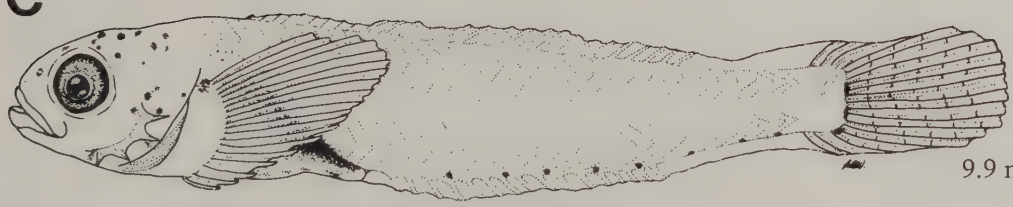
5.2 mm NL

Fork shaped
posterior gut

B

8.2 mm SL

C



9.9 mm SL

Figures A–C, Richardson and Washington 1980.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 35-36-39 | |
| | Precaudal: 10-11-12 | |
| | Caudal: 24-25-27 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 4-4-4 |
| **Dorsal fin** | S: 6-7-8 | R: 15-18-20 |
| **Pectoral fin** | R: 17-19-20 | |
| **Anal fin** | R: 15-16-20 | |
| **Gill rakers** | U: 1-X-3 | L: 8-X-10 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Bering Sea, 54-66°N |
| **Ecology** | Nearshore shelf demersal, intertidal to 91 m |
| **ELH pattern** | Oviparous; demersal, adhesive eggs; pelagic larvae |
| **Spawning** | Season: Oct-Mar (California)[a]<br>Area:<br>Mode:<br>Migration: |
| **Fecundity** | Range/function: 2000-11,000/[b]<br>$N=0.355\times L^{1.84}$,<br>N=no. maturing eggs,<br>L=TL mm[a] |
| **Age at first maturity** | 1 yr[a] |
| **Longevity** | 5 yr[c] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.4-1.5 mm (1.43) |
| **No. of oil globules** | One, smaller ones |
| **Oil globule diameter** | 0.3 mm |
| **Yolk** | |
| **Envelope** | Thick, transparent, bumpy |
| **Hatch size** | 3.8-5.0 mm SL;<br>3.9-4.8 TL[a] |
| **Incubation time/temp.** | 9-14 d/15°C |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 37-40% SL |
| **Length at flexion** | ~8 mm SL |
| **Length at transformation** | 15-20 mm SL |
| **Sequence of fin development** | |

**Pigment**

- Internal snout pigment
- 6-8 bars of pigment on dorsolateral surface of gut
- Postanal ventral midline series

**Diagnostic characters**

- Gut pigment appearing as 6-8 bars
- Internal snout pigment

[a]Jones 1962
[b]Wang 1981
[c]Fitch and Lavenberg 1975

Ref: Jones 1962, Wang 1981, Washington et al. 1984b.

A

5.1 mm NL

B

Snout pigment internal

8.1 mm NL

Bar pattern on gut

C

11.1 mm SL

Figures A–C, Richardson and Washington 1980.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 37-38-38 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 3-3-3 |
| **Dorsal fin** | S: 7-8-9 | R: 20-21-22 |
| **Pectoral fin** | R: 15-16-17 | |
| **Anal fin** | R: 18-19-20 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Brit. Col., 48°30′-55°N, to Bering Sea, 54-66°N |
| **Ecology** | Nearshore shelf demersal |
| **ELH pattern** | Probably oviparous, eggs probably demersal, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

**Preanal length**
**Length at flexion** ⩽12 mm SL
**Length at transformation**
**Sequence of fin development**
**Pigment**

- Entire body heavily pigmented with small, densely packed melanophores except for caudal peduncle, opercle area, and ventrolateral gut surface

**Diagnostic characters** (see Table 3)

- Genus
  - —Elongate body becoming deeper with development
  - —Pigment relatively heavy
  - —Strong frontoparietal ridge

Distinguished from *B. cirrhosus* by

- More pectoral fin rays (15-17)
- Pigment
  - —Larger area of caudal peduncle unpigmented
  - —Smaller, denser melanophores
  - —Lack of pigment on underside of mouth

Figures A–C, NWAFC originals (B. Vinter).

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 37-37-39[a] | |
| | Precaudal: 13-13-13[a] | |
| | Caudal: 26-26-26[a] | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | X, 6+6, X | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 3-3-3 |
| **Dorsal fin** | S: 6-8-8 | R: 20-23-24 |
| **Pectoral fin** | R: 11-12-13 | |
| **Anal fin** | R: 18-19-21 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Cent. California, 34-38°N, to Bering Sea, 54-66°N |
| **Ecology** | Nearshore shelf demersal, intertidal to 37 m |
| **ELH pattern** | Oviparous, demersal eggs, pelagic larvae |
| **Spawning** | Season: Late winter (British Columbia)[b] |
| | Area: Demersal, on rocks[c] |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous |
| **Envelope** | Clear, light brown |
| **Hatch size** | |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | ≤11 mm SL |
| **Length at transformation** | |
| **Sequence of fin development** | |

**Pigment**

- Entire body heavily pigmented except for caudal peduncle, opercle area, and ventrolateral gut surface
- Pigment along underside of mouth between dentary bones (chin)

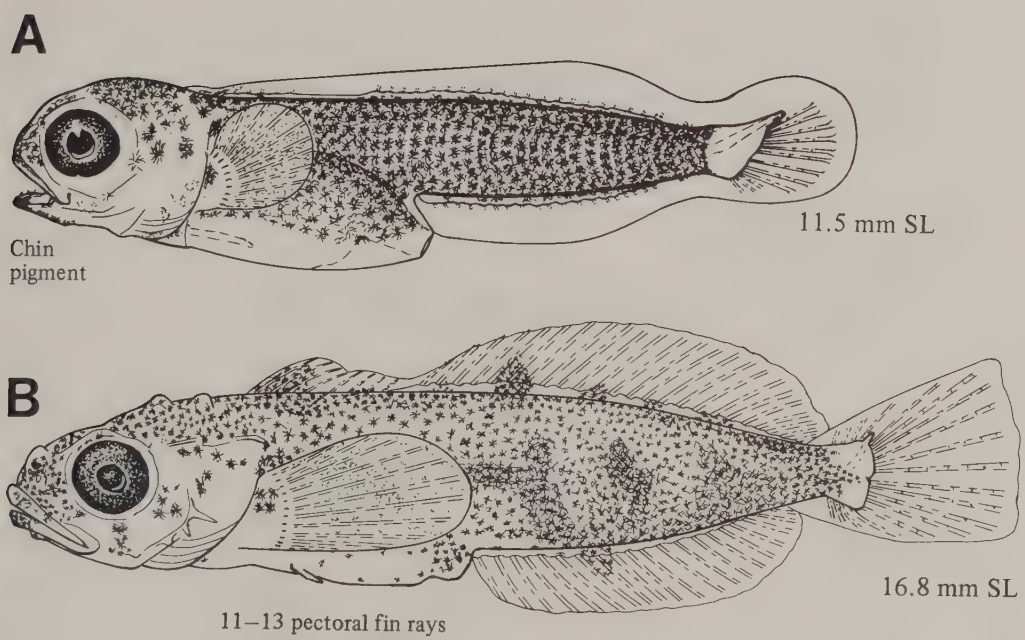
**Diagnostic characters** (see Table 3)

Distinguished from *B. bilobus* by

- Low number of pectoral fin rays (11-13)
- Shorter area of caudal peduncle unpigmented
- Pigment on underside of mouth
- See *B. bilobus* for generic characters (p. 448)

[a] B.B. Washington, NMFS Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560, unpubl.
[b] Marliave 1975a
[c] Clemens and Wilby 1961

Ref: Marliave 1975a, Washington et al. 1984b.




Figures A–B, NWAFC originals (B. Vinter).

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 39-39-41 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 3-3-3 |
| **Dorsal fin** | S: 16-17-19 | R: 11-12-13 |
| **Pectoral fin** | R: 18-19-20 | |
| **Anal fin** | R: 12-14-15 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Gulf of Alaska, 54-60°N, to Bering Sea, 54-66°N |
| **Ecology** | Nearshore shelf demersal |
| **ELH pattern** | Oviparous; demersal, adhesive eggs; pelagic larvae |
| **Spawning** | Season: Fall (Funka Bay, Japan)[a]<br>Area: Rocky sea bottom, 10-30 m[a]<br>Mode:<br>Migration: |
| **Fecundity** | Range/function: 2250-11,170/ $E=0.00002147\times L^{3.374}$, E=ovarian eggs, L=BL mm[a] |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 4.41-4.61 mm |
| **No. of oil globules** | Multiple (120-160) |
| **Oil globule diameter** | 0.05-0.26 mm |
| **Yolk** | Yellow/orange |
| **Envelope** | Thick, white |
| **Hatch size** | 14.1-15.2 mm SL;[a] 10.9-11.6 mm SL[b] |
| **Incubation time/temp.** | 100 d/12°C |

**Pigment**
- Light on yolksac

**Diagnostic characters**
- Oil globules coalesce to one by late embryonic development

### LARVAE

| | |
|---|---|
| **Preanal length** | ~50% SL |
| **Length at flexion** | ≤14.4 mm SL (close to hatching) |
| **Length at transformation** | ~20 mm SL |
| **Sequence of fin development** | |

**Pigment**
- Heavily pigmented at hatching (head, 3/4 BL, and dorsolateral surface of gut)
- Distinctive finfold pigment

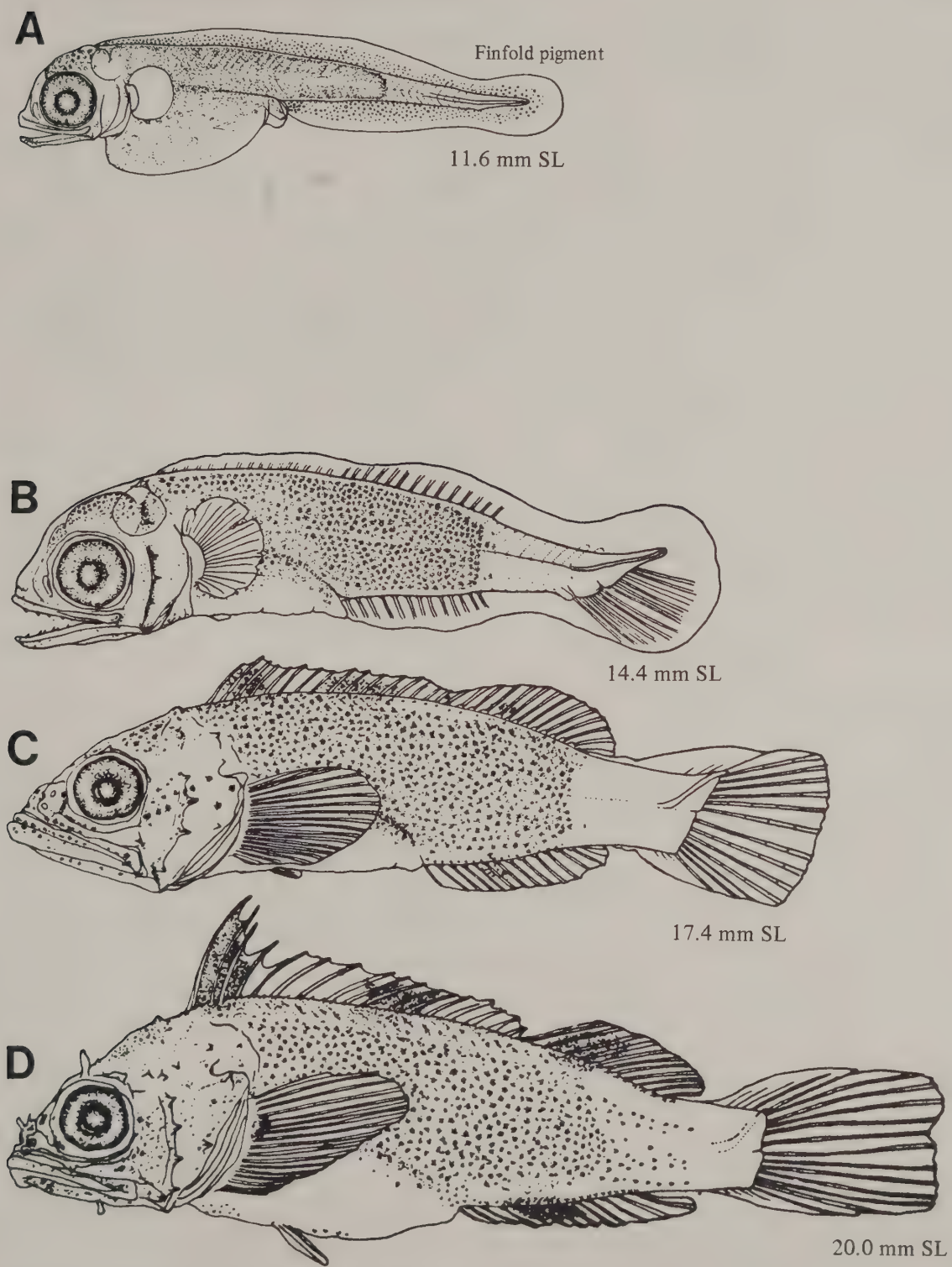
**Diagnostic characters** (see Table 3)
- *Hemitripterus* group characters
- Finfold pigment
- Prickles, scales
- Newly hatched larvae large and well developed

Eggs and larvae of *H. bolini* are unknown. The following information will aid in identification.

| | |
|---|---|
| Total vertebrae | 38-40 |
| Dorsal fin spines | 11-15 |
| Dorsal fin rays | 11-14 |
| Anal fin rays | 12-14 |
| Pectoral fin rays | 20-22 |
| Pelvic fin rays | 3 |
| Range | N. Calif.[c] - Bering Sea |

[a] Kyushin 1968
[b] Okiyama and Sando 1976
[c] Lea and Quirollo 1986

Ref: Kyushin 1968, Okiyama and Sando 1976.




Figures A–D, Okiyama and Sando 1976 (reared from specimens collected near Hokkaido, Japan).

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 40-41-41 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 3-3-3 |
| **Dorsal fin** | S: 8-8-9 | R: 27-29-30 |
| **Pectoral fin** | R: 13-14-14 | |
| **Anal fin** | R: 16-19-21 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Cent. California, 34-38°N, to Bering Sea, 54-66°N |
| **Ecology** | Nearshore shelf demersal, 0-110 m |
| **ELH pattern** | Oviparous; demersal, adhesive, attached eggs; pelagic larvae |
| **Spawning** | Season: Fall-spring[a]<br>Area: Intertidal, in mussel zone[a]<br>Mode:<br>Migration: Females move from subtidal area to mussel zone to deposit eggs[a] |
| **Fecundity** | Range/function: |
| **Age at first maturity** | 1 yr[b] |
| **Longevity** | |

[a] J. Marliave, Vancouver Public Aquarium, P.O. Box 3232, Vancouver, B.C., Canada V6B 3X8, pers. commun., 16 Oct. 1986.
[b] Fitch and Lavenberg 1975
[c] Andriashev 1954; eggs 2.5-2.7 mm.

Ref: Blackburn 1973, Marliave 1975a, Richardson and Washington 1980, Washington et al. 1984b.

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 2.0-2.5 mm |
| **No. of oil globules** | One |
| **Oil globule diameter** | |
| **Yolk** | Orange |
| **Envelope** | |
| **Hatch size** | ~9 mm TL (possibly as small as 7 mm TL) |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**
- Wild: Only egg with bright orange yolk laid in *Mytilus* beds[a]

### LARVAE

| | |
|---|---|
| **Preanal length** | ~50% SL |
| **Length at flexion** | ~9-11 mm SL |
| **Length at transformation** | ~26 mm SL (largest pelagic specimen caught = 16-17 mm SL) |
| **Sequence of fin development** | |

**Pigment**
- Finfold pigment
- Distinctive pigment over lateral surface of trunk
- Pectorals pigmented in band posteriorly

**Diagnostic characters** (see Table 3)
- Long pigmented pectorals (of sample size = 2, length of pectorals ranged from 42 to 59% SL)
- Bumps and parietal ridge

The following information will aid in identification of *N. pribilovius* (larvae unknown)[c] and *N. robustus* (eggs and larvae unknown).

| | *N. pribilovius* | *N. robustus* |
|---|---|---|
| Total vertebrae | 36-37 | 35 |
| Dorsal fin spines | 7-10 | 7- 8 |
| Dorsal fin rays | 22-26 | 19-21 |
| Anal fin rays | 15-20 | 14-15 |
| Pectoral fin rays | 15-17 | 14-16 |
| Pelvic fin rays | 3 | 3 |
| Range | SE Alaska - Chukchi Sea | Wash. - Bering Sea |

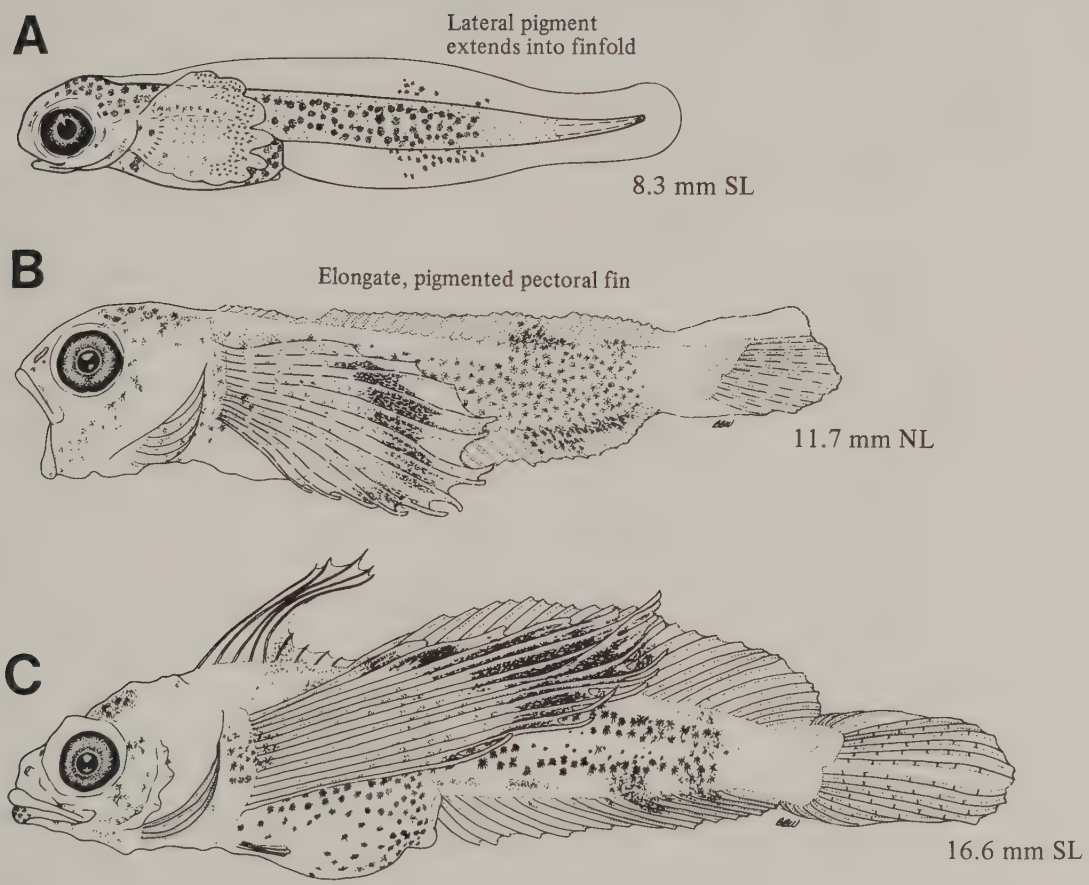



Figure A, NWAFC original (B. Vinter); B–C, Richardson and Washington 1980.

Poachers and alligatorfishes range from Baja California to the Bering Sea, with the center of abundance in the North Pacific. They are mostly elongate with large fused bony plates covering the body. Pectoral fins are fanlike. Adults are demersal and occur from moderate depths to 1250 m. Some have also been found in tidepools (Hart 1973, Garrison and Miller 1982). The family is represented by 25 species and 15 genera within the study area. Among the few species studied, demersal adhesive eggs are attached to holdfasts of laminarians (Breder and Rosen 1966, Garrison and Miller 1982). Larvae are pelagic and are occasionally taken in plankton nets near the surface. Bony plates, characteristic of agonids, first appear in the larvae as spines. Settlement in some species may occur at approximately 2 months after hatching (Marliave 1975a). Descriptions of larvae of three species are available for inclusion here (*Agonomalus mozinoi*, *Bothragonus swani*, and *Xeneretmus latifrons*). Illustrations of single specimens are provided for *Stellerina*, *Hypsagonus*, *Ocella*, *Aspidophoroides* (species outside study area), and an unidentified agonid. Two illustrations are provided for Agonidae A, another unidentified agonid from the study area.

**Table 39**

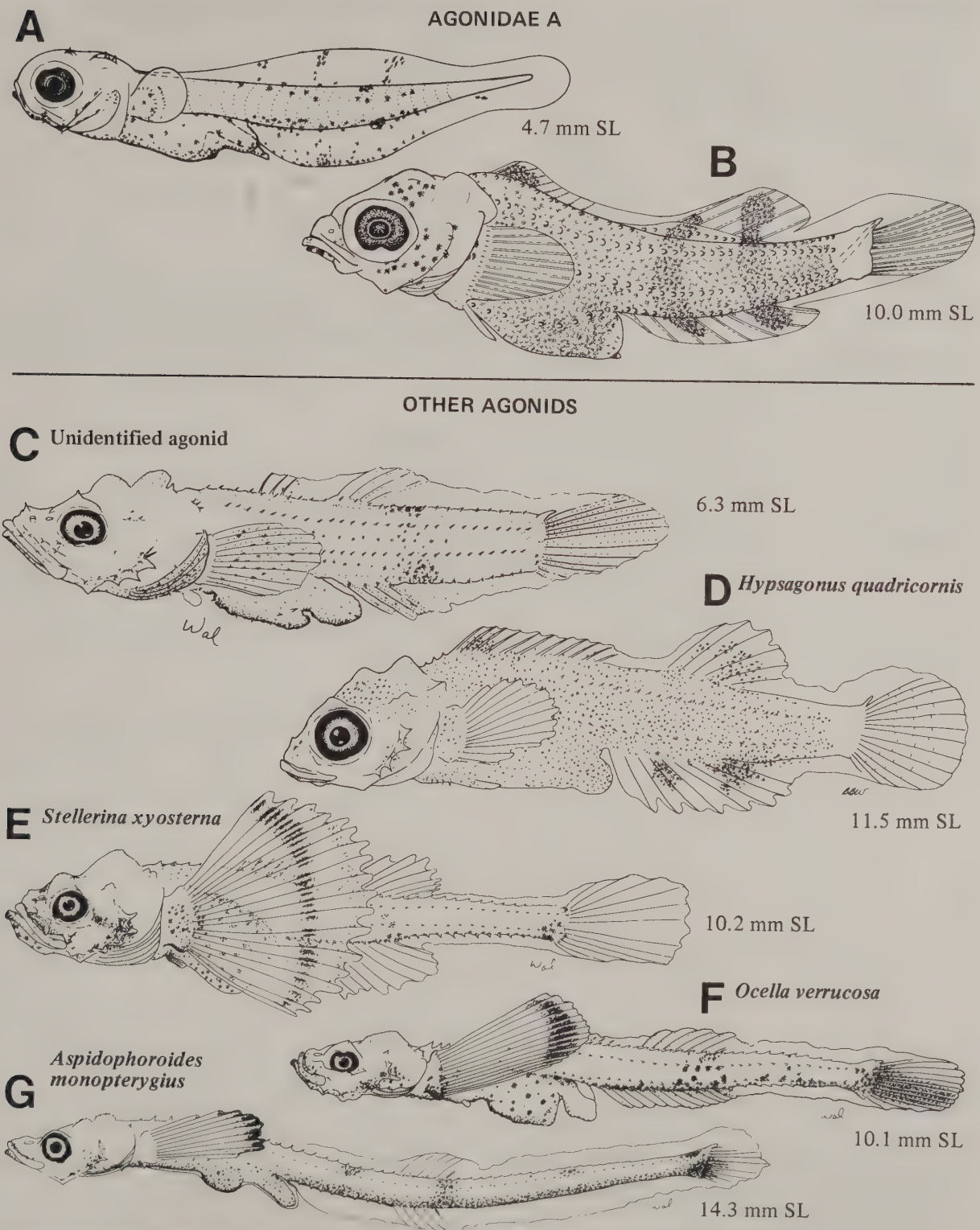
**Meristic characters of family Agonidae. All have pelvic counts of I,2 and 6 branchiostegal rays.**

| | | Vertebrae | | Fins | | | Gill rakers | |
|---|---|---|---|---|---|---|---|---|
| Taxon | Distribution | Precaudal (Total) | Caudal | Dorsal | Anal | Pectoral | Upper (Total) | Lower |
| *Agonomalus mozinoi* | Cent. Calif.-Brit. Col. | | | VIII-IX,6-8 | 11-12 | 11-12 | | |
| *Agonopsis vulsa* | SSC-Gulf of Alaska | (39-42) | | VIII-X,7-9 | 10-12 | 13-15 | | |
| *Agonus acipenserinus*[a] | N. Calif.-Chukchi Sea | (39-41) | | VII-X,6-9 | 6-9 | 16-19 | | |
| *Agonus decagonus*[a] | Bering Sea-Arctic | (47-48)[b] | | V-VII,5-8 | 6-8 | 13-16 | | |
| *Anoplagonus inermis* | N. Calif.-Aleutian Is. | (41-45) | | 4-6 | 4-5 | 8-10 | | |
| *Aspidophoroides bartoni* | Gulf of Alaska-Arctic | (51-53) | | 4-6 | 4-6 | 9-10 | | |
| *Aspidophoroides olrikii* | Bering Sea-Arctic | (38-40) | | 5-7 | 5-7 | 13-16 | | |
| *Bathyagonus alascanus* | N. Calif.-Bering Sea | (39-41) | | V-VIII,5-8 | 6-8 | 15 | | |
| *Bathyagonus infraspinatus* | N. Calif.-Bering Sea | (38-39) | | V-VIII,5-8 | 5-8 | 15-16 | | |
| *Bathyagonus nigripinnis* | N. Calif.-Bering Sea | (44-45) | | VI-VIII,6-7 | 7-9 | 15-16 | | |
| *Bathyagonus pentacanthus* | S. Calif.-Bering Sea | (40-46) | | V-VIII,5-8 | 6-9 | 14-16 | | |
| *Bothragonus swani* | Cent. Calif.-Gulf of Alaska | (29-31) | | II-V,4-6 | 4-5 | 10-12 | | |
| *Hypsagonus quadricornus* | Wash.-Bering Sea | (36) | | IX-XI,5-7 | 9-11 | 12-14 | | |
| *Ocella dodecaedron* | Aleutian Is.-Chukchi Sea | (38-39) | | IX-XI,7-8 | 14-16 | 14-15 | | |
| *Ocella impi*[c] | Brit. Col. | (37)[b] | | IX,6 | 9 | 18 | | |
| *Ocella verrucosa* | Cent. Calif.-Bering Sea | 13-14 | 21-24 | VII-IX,6-9 | 7-12 | 14-15 | 1-2 | 8-12 |
| *Odontopyxis trispinosa* | SSC-SE Alaska | 10-12 | 27-30 | III-VI,5-7 | 5-7 | 13-15 | | 7 |
| *Pallasina barbata* | Cent. Calif.-Bering Sea | (45-47) | | V-IX,6-7 | 9-14 | 10-13 | | |
| *Percis japonicus* | Bering Sea | (42) | | V-VII,6 | 7-9 | 12 | | |
| *Sarritor frenatus* | Brit. Col.-Bering Sea | (46-48) | | VI-VIII,6-8 | 6-7 | 15-17 | | |
| *Sarritor leptorhynchus* | Gulf of Alaska-Bering Sea | (42-44) | | VI-IX,5-8 | 6-8 | 13-15 | | |
| *Stellerina xyosterna* | SSC-Brit. Col. | (34-37) | | VI-VIII,5-7 | 8-9 | 17-19 | 1-2 (10-14) | 8-12 |
| *Xeneretmus latifrons* | SSC-Brit. Col. | 11-13 | 28-30 | VI-VIII,6-8 | 6-9 | 13-15 | | 10-11 |
| *Xeneretmus leiops* | S. Calif.-SE Alaska | (39-42) | | VI-VII,6-8 | 5-8 | 13-15 | | |
| *Xeneretmus triacanthus* | SSC-Brit. Col. | 12 | 29-30 | V-VII,6-7 | 5-7 | 12-14 | 1 | 8-13 |

[a] Placement in the genus *Agonus* is questionable (Lea and Dempster 1982).

[b] W.A. Laroche, 24 Maple Park, Box 216, Enosburg Falls, VT 05450, pers. commun., 10 Dec. 1986.

[c] *Ocella impi* may not be a valid species, rather it may be the juvenile of *Stellerina xyosterna* (A.E. Peden, Brit. Col. Prov. Mus., Victoria, B.C., Canada V8V 1X4, pers. commun., 22 Jan. 1987).




Figures A–B, NWAFC originals (B. Vinter); C–G, Washington et al. 1984b (Figure C was misidentified in Washington et al. (1984b) as *Bothragonus swani*; G, Atlantic specimen).

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: X-X-X | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 2-2-2 |
| **Dorsal fin** | S: 8-X-9 | R: 6-X-8 |
| **Pectoral fin** | R: 11-X-12 | |
| **Anal fin** | R: 11-X-12 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Cent. California, 34-38°N, to Brit. Col., 48°30′-55°N |
| **Ecology** | Nearshore shelf demersal, intertidal to 11 m |
| **ELH pattern** | Oviparous, demersal eggs, pelagic larvae |
| **Spawning** | Season: Winter-spring[a]<br>Area:<br>Mode: Repeated deposition of eggs in separate masses[b]<br>Migration: |
| **Fecundity** | Range/function: 6-25 eggs/mass[b] |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | ~1 mm |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | Red |
| **Envelope** | |
| **Hatch size** | 5.5 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE[c]

**Preanal length**
**Length at flexion**
**Length at transformation**
**Sequence of fin development**
**Pigment**

- Dorsal and ventral finfolds
- Heavily pigmented body, pigment increasing with development

**Diagnostic characters**

- Based on one specimen (8.2 mm SL), they are superficially similar to cottid *Hemitripterus* group (p. 448)

[a] W.A. Laroche, 24 Maple Park, Box 216, Enosburg Falls, VT 05450, pers. commun., 10 Dec. 1986.
[b] J. Marliave, Vancouver Public Aquarium, P.O. Box 3232, Vancouver, B.C., Canada V6B 3X8, pers. commun., 16 Oct. 1986.
[c] Incomplete series.

Ref: Washington et al. 1984a,b.

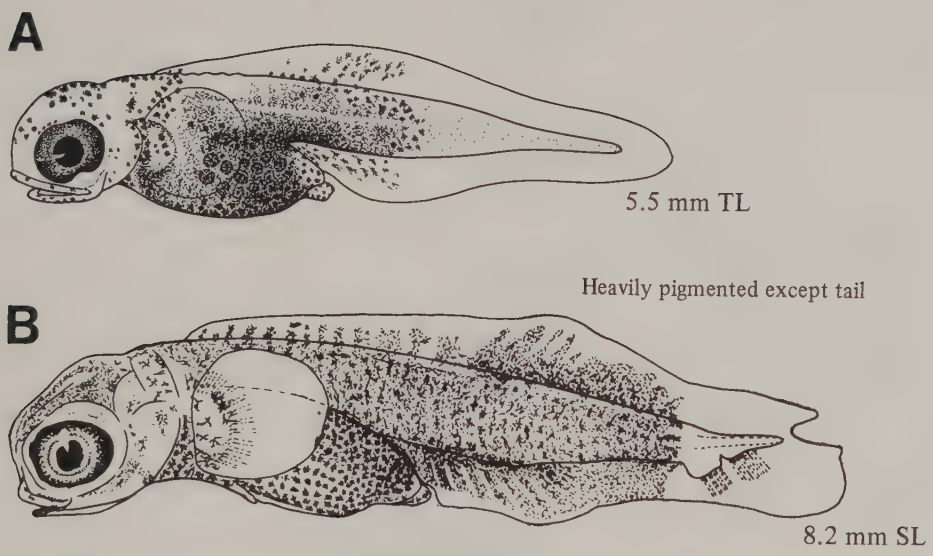



Figure A, Marliave 1978; B, NWAFC original (B. Vinter).

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 29-30-31 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 2-2-2 |
| **Dorsal fin** | S: 2-3-5 | R: 4-5-6 |
| **Pectoral fin** | R: 10-12-12 | |
| **Anal fin** | R: 4-4-5 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Cent. California, 34-38°N, to Gulf of Alaska, 54-60°N |
| **Ecology** | Nearshore shelf demersal, intertidal to 18 m |
| **ELH pattern** | Oviparous; demersal, attached eggs; pelagic larvae |
| **Spawning** | Season: Winter-spring[a] |
| | Area: On kelp holdfasts[b] |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 2 mm |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | 7.5 mm TL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | |
| **Length at flexion** | ~10-12 mm TL |
| **Length at transformation** | >16 mm TL |
| **Sequence of fin development** | |

**Pigment**

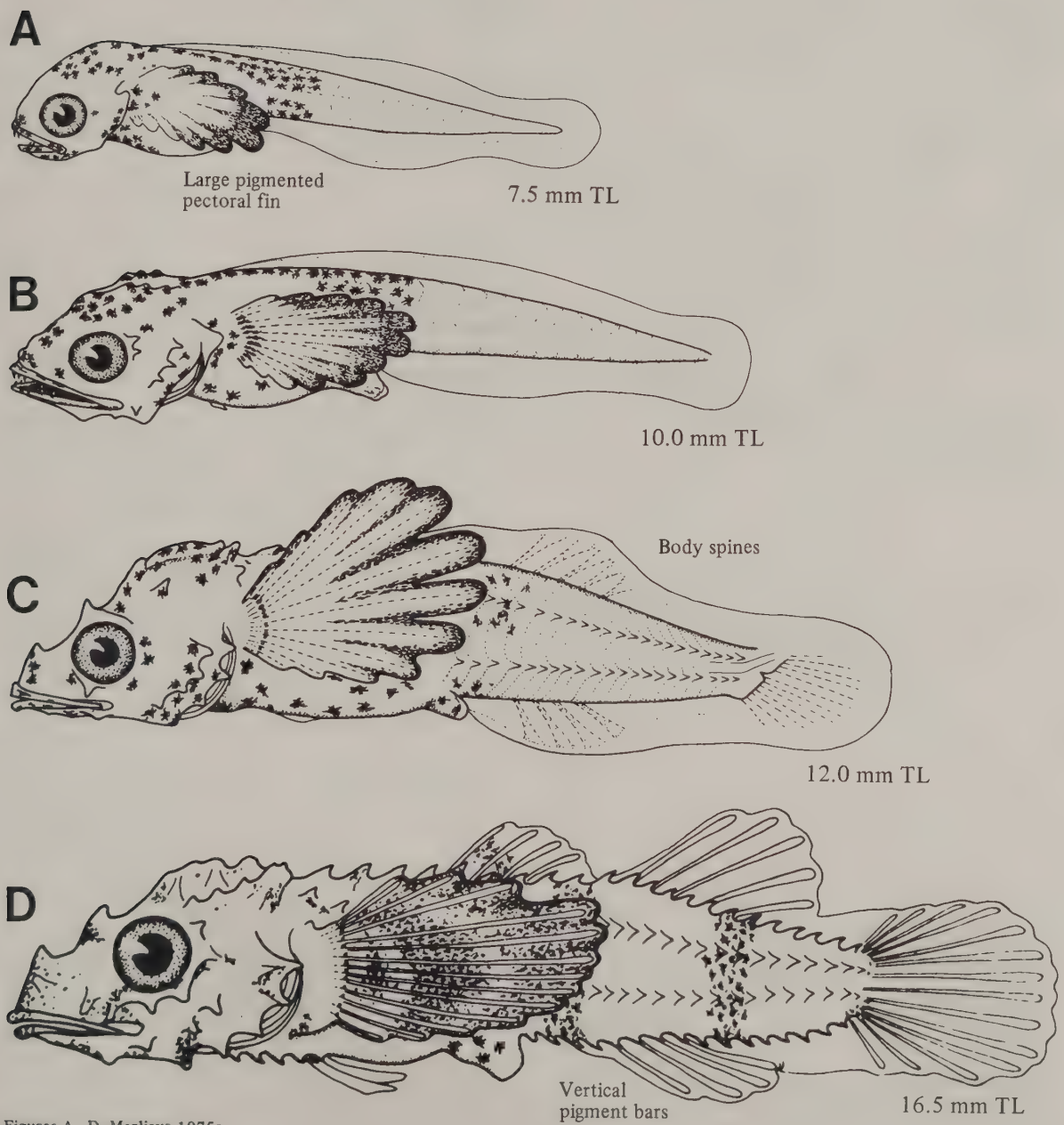
- Upper and lower jaw
- Dorsal head
- Anterior gut and body
- Outer edge of pectoral fin
- Flexion and postflexion larvae develop several vertical bars on body

**Diagnostic characters**

- Large pigmented pectoral fins
- Body spines develop in flexion larvae
- Body short and stocky compared with *Xeneretmus latifrons*

[a] W.A. Laroche, 24 Maple Park, Box 216, Enosburg Falls, VT 05450, pers. commun., 10 Dec. 1986.
[b] Marliave 1975a

Ref: Marliave 1975a, Washington et al. 1984b.




Figures A–D, Marliave 1975a.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 39-41-42 | |
| | Precaudal: 11-12-13 | |
| | Caudal: 28-29-30 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 2-2-2 |
| **Dorsal fin** | S: 6-7-8 | R: 6-7-9 |
| **Pectoral fin** | R: 13-14-15 | |
| **Anal fin** | R: 6-7-9 | |
| **Gill rakers** | U: X-X-X | L: 10-X-11 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Brit. Col., 48°30′-55°N |
| **Ecology** | Epi- and mesobenthal, 18-400 m |
| **ELH pattern** | Oviparous, eggs probably demersal, pelagic larvae |
| **Spawning** | Season: Spring[a,b] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | ~7 mm TL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | |
| **Length at flexion** | ~10 mm TL |
| **Length at transformation** | |
| **Sequence of fin development** | |

**Pigment**[c]

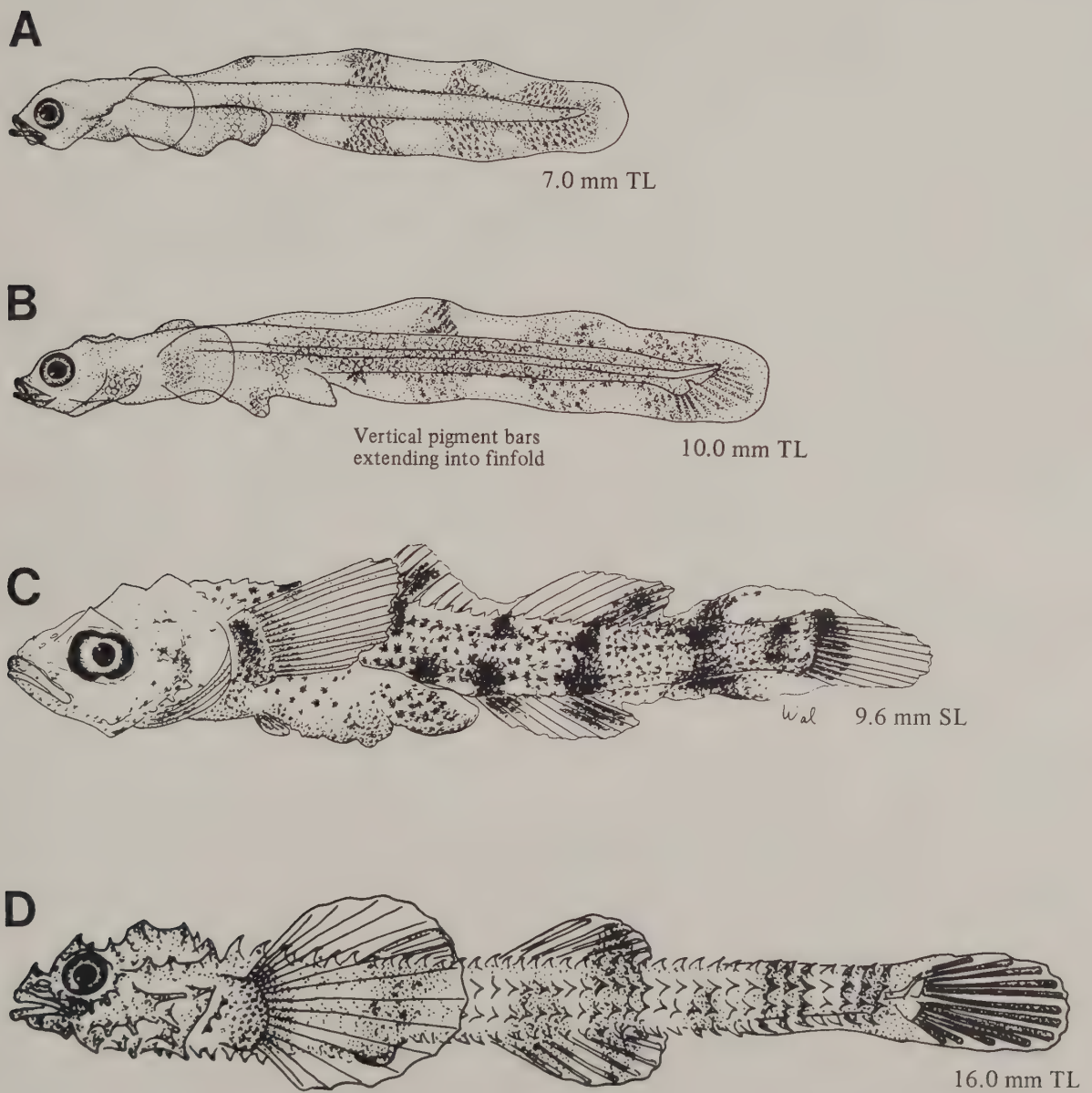
- Body pigment extending into finfold in four vertical bars: Over posterior gut, midbody, at 3/4 body length, and tail region
- Preflexion larvae have pigment on jaws

**Diagnostic characters**

- Four vertical pigment bars extending into finfolds
- Body spines develop in postflexion larvae
- Long slender body compared with *Bothragonus swani*

[a] Marliave 1975a
[b] Fitch and Lavenberg 1968
[c] J. Marliave, Vancouver Public Aquarium, P.O. Box 3232, Vancouver, B.C., Canada V6B 3X8, pers. commun., 16 Oct. 1986.

Ref: Marliave 1975a, Washington et al. 1984b.




Figures A–B, D, Marliave 1975a (D, length in Marliave 1975a is given as 21.0 mm TL [footnote c]) ; C, Washington et al. 1984b.

The family Cyclopteridae is composed of two subfamilies: the Cyclopterinae (lumpsuckers) and the Liparidinae (snailfishes). Although both subfamilies possess a ventral sucking disc, many differences distinguish the two groups (e.g., lumpsuckers have 2 dorsal fins and about 23-29 vertebrae, and snailfishes have a single dorsal fin and about 38-86 vertebrae).

## Cyclopterinae

Cyclopterines are found exclusively in the cooler waters of the Northern Hemisphere. The subfamily is represented by eleven species in five genera in the Northeast Pacific and Bering Sea. Mostly benthic, adults may be found clinging to rocks in tidal zones or in rocky habitat as deep as 225 m (Hart 1973). Eggs, which are adhesive, 1.9-5.0 mm in diameter, and may contain one or more oil globules, are laid in nest sites within rocky crevices or shells and are guarded during incubation (Able et al. 1984). Newly hatched larvae may be identified as cyclopterines by their stout body shape, heavy pigmentation, large sucking disc on the ventral surface, and advanced state of development. They are found attached to substrate and prefer areas with current (A.C. Matarese and S.F. Borton, unpubl.). Larvae of only two species can be identified in our area, *Aptocyclus ventricosus* and *Eumicrotremus orbis*.

**Table 40**
**Meristic characters of subfamily Cyclopterinae. All have pelvic discs and six branchiostegal rays.**

| | | Vertebrae | | Fins | | | Gill rakers | |
|---|---|---|---|---|---|---|---|---|
| Taxon | Distribution | Precaudal | Caudal | Dorsal | Anal | Pectoral | Upper | Lower |
| *Aptocyclus ventricosus* | Brit. Col.-Bering Sea | 14 | 13-15 | V,8-11 | 6-9 | 19-22 | | 5-7 |
| *Cyclopteropsis phrynoides* | Gulf of Alaska-Bering Sea | | | VII,11 | | 25 | | |
| *Eumicrotremus andriashevi* | Bering Sea-Chukchi Sea | | | VI-VII,10-12 | 10-11 | 23-27 | | |
| *Eumicrotremus barbatus* | Aleutian Is. | 11 | 16 | VII,11 | 10 | 23 | | |
| *Eumicrotremus birulai* | Gulf of Alaska-Bering Sea | 11 | 17 | VI-VII,9-12 | 9-11 | 25-29 | | 6-9 |
| *Eumicrotremus gyrinops* | Aleutian Is.-Bering Sea | | | VIII,9 | 9 | 24 | | |
| *Eumicrotremus orbis* | Wash.-Bering Sea | 10-11 | 17-18 | V-VII,9-11 | 9-11 | 19-27 | | 5-6 |
| *Eumicrotremus soldatovi* | Bering Sea | 11 | 18 | VI,11-12 | 10 | 24 | | |
| *Eumicrotremus taranetzi* | Bering Sea | 11 | 16 | V-VI,9-10 | 9-10 | 24-26 | | 6-7 |
| *Lethotremus muticus* | Aleutian Is.-Bering Sea | | | VII,11 | 10 | 23 | | |
| *Pelagocyclus vitiazi* | Bering Sea | | | IV-V,9-10 | 8-9 | 19-21 | | |

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 27-X-29 | |
| | Precaudal: 14-14-14 | |
| | Caudal: 13-X-15 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Disc | |
| | S: X-X-X | R: X-X-X |
| **Dorsal fin** | S: 5-5-5 | R: 8-10-11 |
| **Pectoral fin** | R: 19-20-22 | |
| **Anal fin** | R: 6-8-9 | |
| **Gill rakers** | U: X-X-X | L: 5-X-7 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Brit. Col., 48°30′-55°N, to Bering Sea, 54-66°N |
| **Ecology** | Epi-, meso-, and bathypelagic, 0-1500 m |
| **ELH pattern** | Oviparous; demersal, adhesive eggs; demersal larvae |
| **Spawning** | Season:<br>Area:<br>Mode: Males guard eggs[a]<br>Migration: |
| **Fecundity** | Range/function: 3800[a] |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 2.3-2.4 mm |
| **No. of oil globules** | (Present) |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | 6.5-7.0 mm TL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 33% SL |
| **Length at flexion** | 6.5-7.0 mm TL |
| **Length at transformation** | |
| **Sequence of fin development** | Pectorals and pelvic disc form before hatching |

**Pigment**

- Initially, body is lightly pigmented but with development pigment increases to cover entire body

**Diagnostic characters**

- Smooth body (lack of spines)

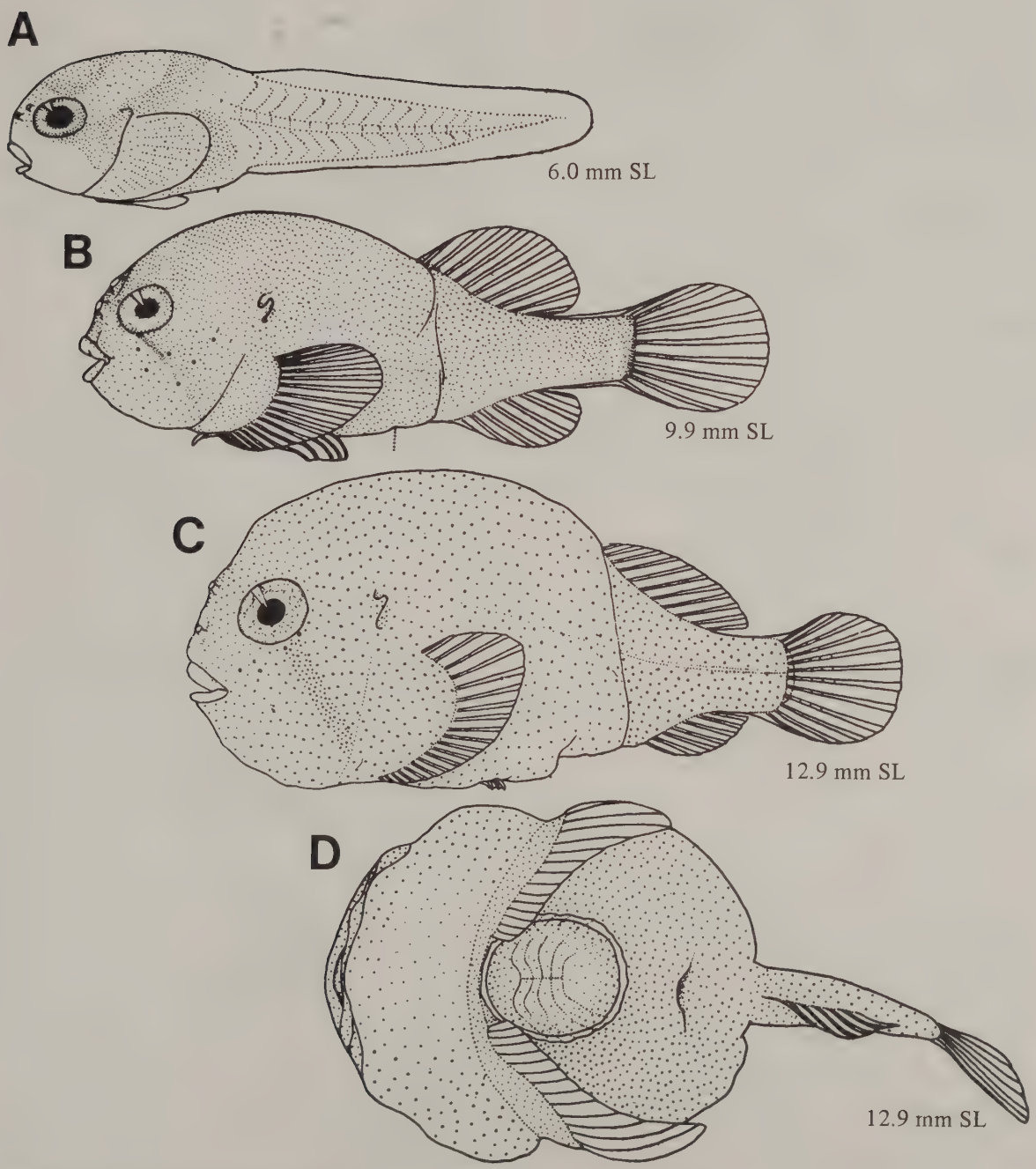
Distinguished from other cyclopterines by

- Distribution
- Meristic characters:

| | |
|---|---|
| Total vertebrae | 27-29 |
| Dorsal fin spines | 5 |
| Dorsal fin rays | 8-11 |
| Anal fin rays | 6-9 |

[a] Able et al. 1984

Ref: Able et al. 1984, Kobayashi 1962.




Figures A–D (D, ventral view), Kobayashi 1962 (A, reared from specimens collected near Hokkaido, Japan).

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 26-X-29 | |
| | Precaudal: 10-X-11 | |
| | Caudal: 17-X-18 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | X, 5+4, X | |
| | Total rays=9-12 | |
| **Pelvic fin** | Disc | |
| | S: 1-1-1 | R: 5-5-5 |
| **Dorsal fin** | S: 5-6-7 | R: 9-10-11 |
| **Pectoral fin** | R: 19-23-27 | |
| **Anal fin** | R: 9-10-11 | |
| **Gill rakers** | U: X-X-X | L: 5-X-6 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Washington, 46-48°30′N, to Chukchi Sea, north of 66°N |
| **Ecology** | Epi-, meso-, and bathybenthal, 0-575 m |
| **ELH pattern** | Oviparous; demersal, attached, adhesive eggs; demersal larvae |
| **Spawning** | Season: Fall-winter (Brit. Col.)[a]<br>Area:<br>Mode: Males guard eggs laid in nests[b]<br>Migration: |
| **Fecundity** | Range/function: 305-1590 (737 at 52.5 mm)/ $F=47.67\times L-1766.86$, L=TL mm[b] |
| **Age at first maturity** | 1 yr (males)[b] |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.9-2.2 mm |
| **No. of oil globules** | One to multiple |
| **Oil globule diameter** | |
| **Yolk** | Clear, homogeneous |
| **Envelope** | Translucent |
| **Hatch size** | 4.5-4.7 SL |
| **Incubation time/temp.** | 26 d/9.7-12.0°C |
| **Pigment** | |

**Diagnostic characters**

- Degree of body pigment
- Precocious fin development

### LARVAE

| | |
|---|---|
| **Preanal length** | 50-75% SL |
| **Length at flexion** | Prior to hatch |
| **Length at transformation** | 6.9-8.7 mm SL |
| **Sequence of fin development** | Pelvics and caudal (prior to hatch), dorsal spines, dorsal rays, pectorals, anal (although caudal development is initiated prior to hatch, it is the last to complete development) |

**Pigment**

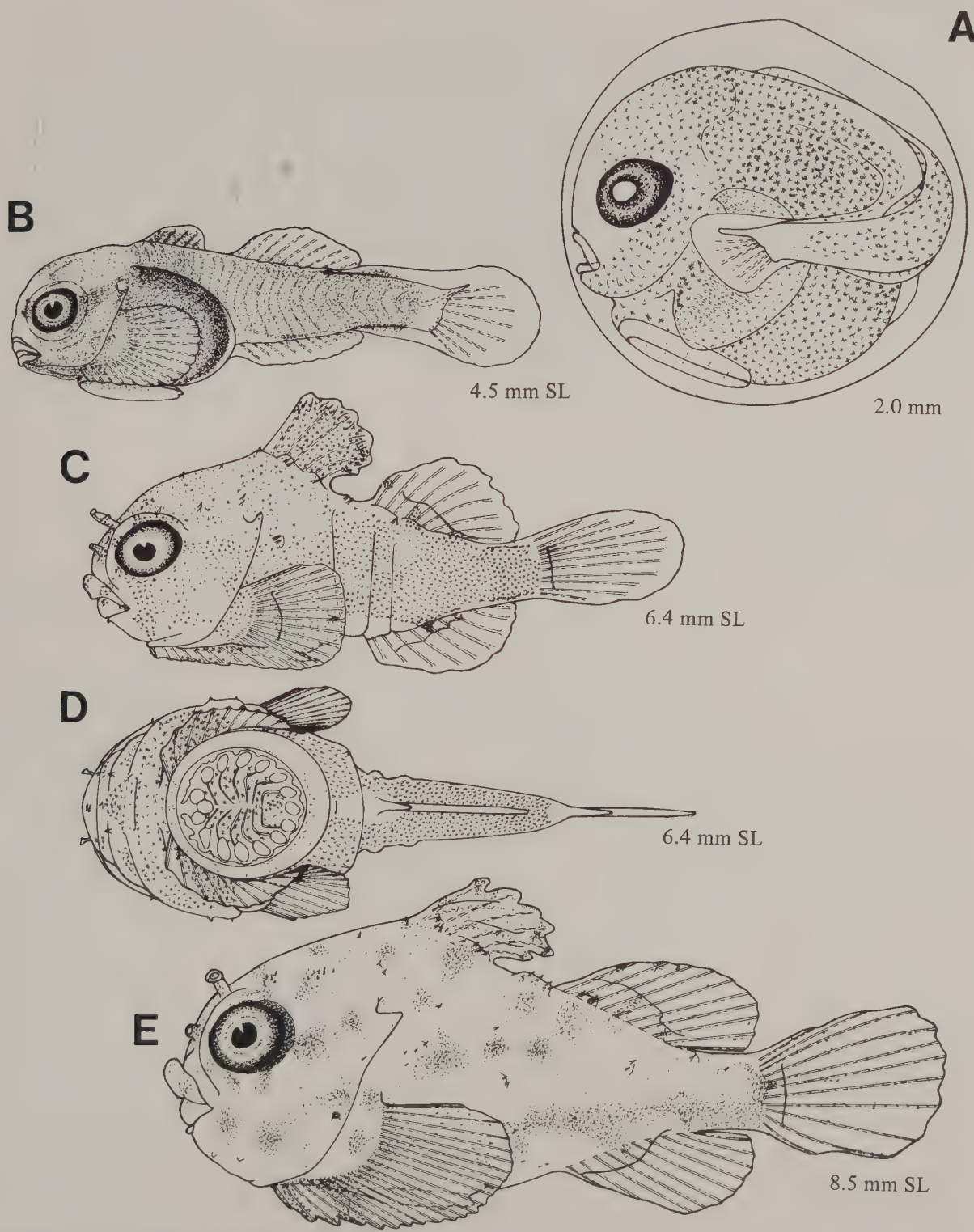
- Initially, heavily pigmented except caudal peduncle, area around anus, first three anal rays, and snout

**Diagnostic characters**

- Pigment: Small melanophores covering most of body and dorsal fin
- Morphology: Globular shape, spines
- Precocious fin development

[a] Arita 1969
[b] A.C. Matarese and S.F. Borton, unpubl.

Ref: Matarese and Borton, unpubl.



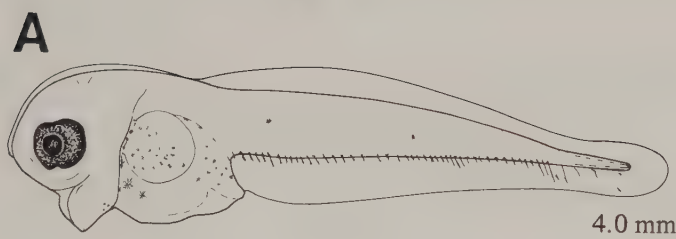

Figures A–E (D, ventral view), Matarese and Borton, unpubl.

## Liparidinae

This large subfamily is circumpolar about both poles in distribution. Within the study area there are 74 described species within 14 genera. Adults are demersal or pelagic and have been found from tidepools to depths of 7000 m (Hart 1973, Able et al. 1984). Spawning habits are diverse. Adhesive clumps of eggs (1-8 mm) have been seen attached to algae, mollusc shells, and tubeworms; eggs and larvae of *Careproctus* spp. have been found in gill cavities of lithodid crabs (Anderson and Cailliet 1974). Parental care of eggs (i.e., hiding, paternal guarding, or both) is exhibited in most taxa studied. Most species studied, especially deep-water forms, hatch at an advanced stage of development (Able et al. 1984). Larvae are planktonic or benthic. Only one complete larval series is available from our area, *Rhinoliparis barbulifer*. Illustrations of two unidentified larvae are provided since each of them is relatively common in our collection. The small larva (4.0 mm SL) is common in our Gulf of Alaska collections whereas the larger larva (5.8 mm SL) is routinely collected in our surveys along the Pacific Coast and represents one of the ten most abundant groups of ichthyoplankton collected off Oregon (Mundy, pers. commun.)[1]. Representatives of specimens from other areas (Atlantic, Arctic) are presented for three genera: *Careproctus*, *Paraliparis*, and *Liparis*. Early juvenile specimens of *Paraliparis* sp. (probably *P. deani*) are occasionally collected in plankton nets. Illustrations of a tentatively identified partial series of *Nectoliparis pelagicus* are also provided.

[1]B. Mundy, NMFS Southwest Fish. Cent., Honolulu Lab., 2570 Dole St., Honolulu, HI 96822-2396, pers. commun., 1 Oct. 1986.

Unidentified Liparidinae



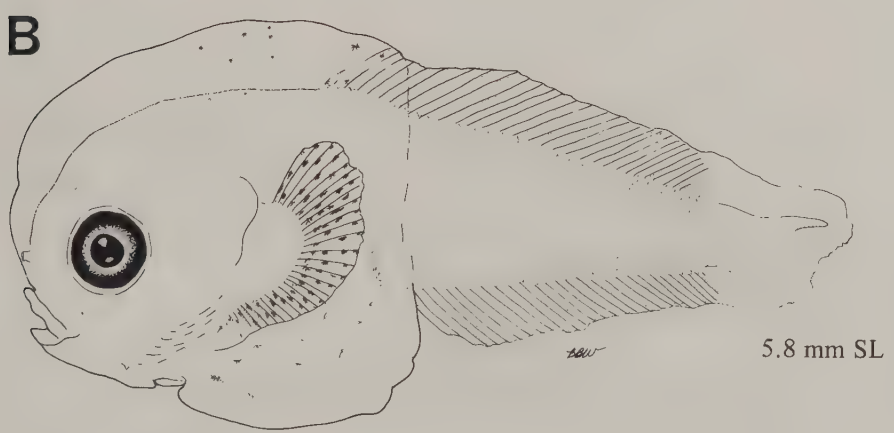
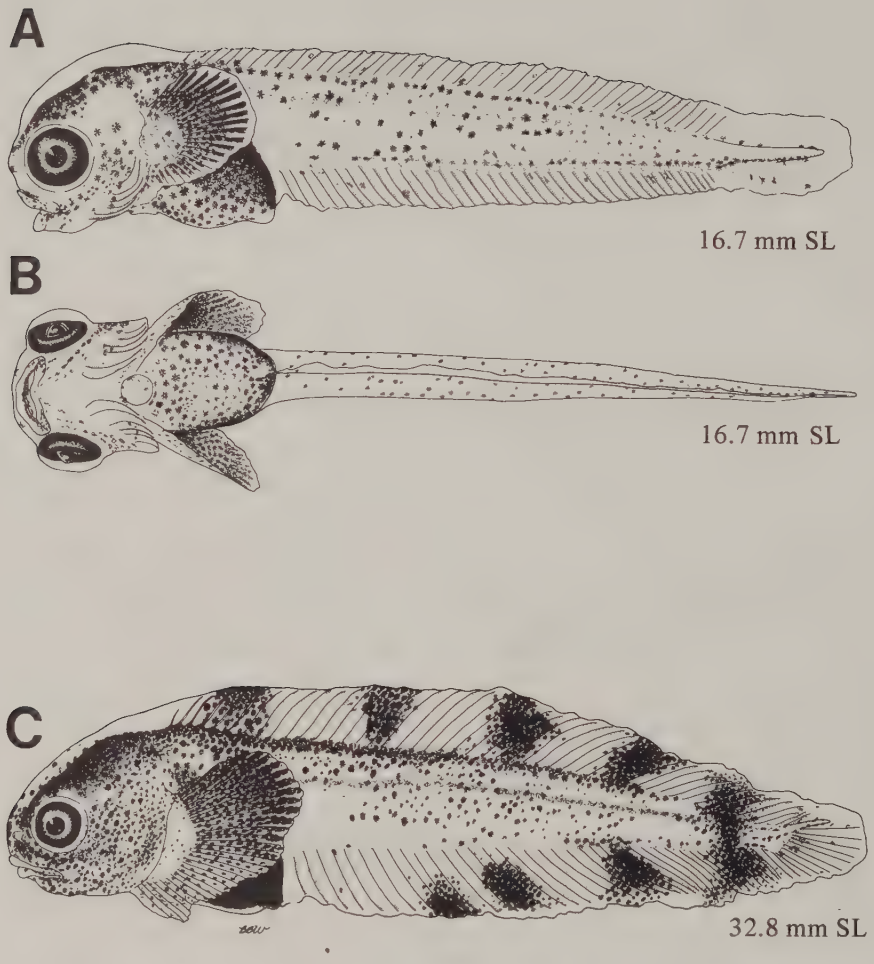



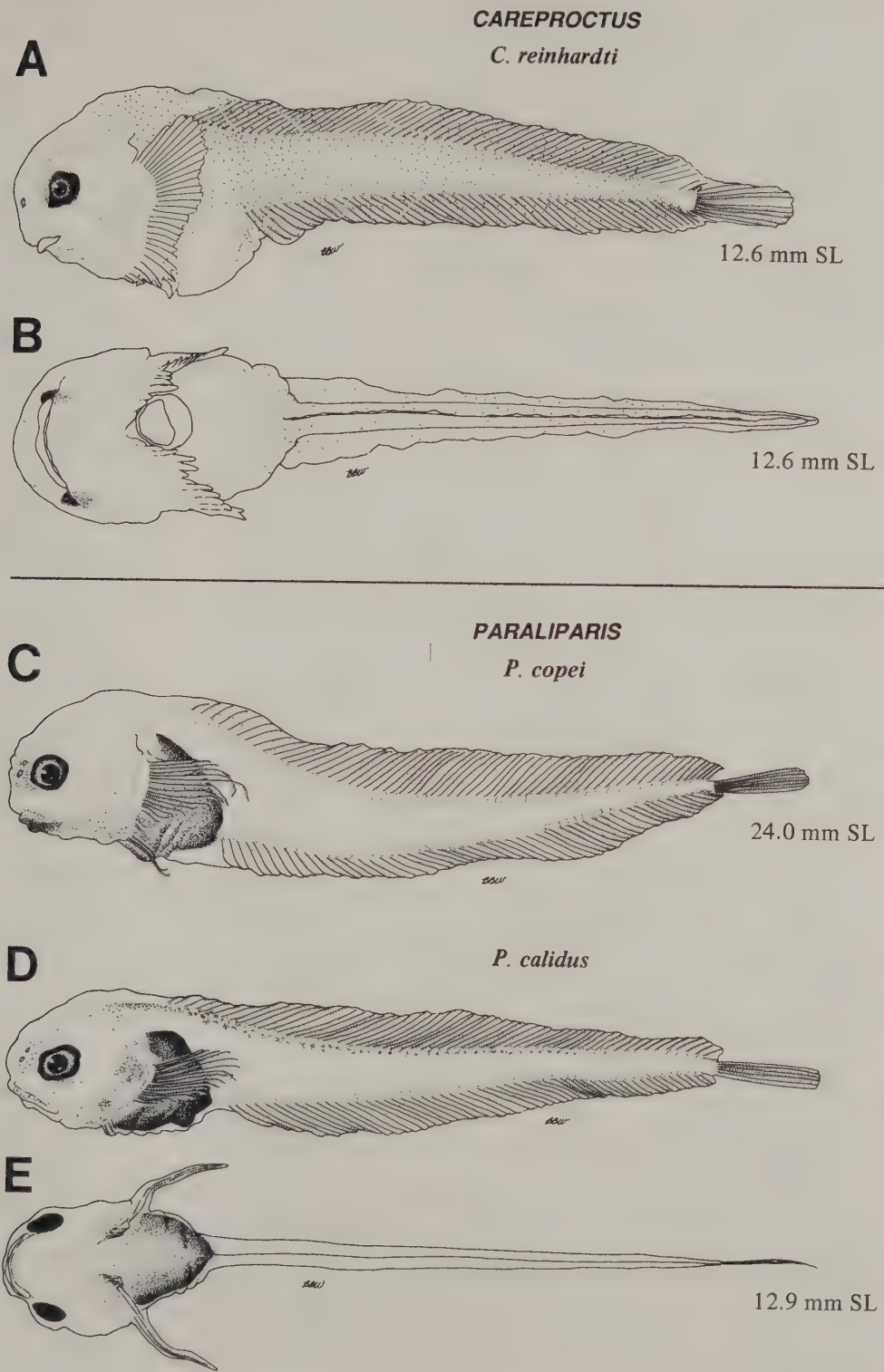

Figure A, NWAFC original (B. Vinter); B, Able et al. 1984.

***LIPARIS***

*L. fabricii*




Figures A–C (B, ventral view), Able et al. 1984 (Arctic specimens).




Figures A–E (B, E, ventral views), Able et al. 1984 (Atlantic specimens).

## Table 41
**Meristic characters of subfamily Liparidinae.[a]**

| Taxon | Distribution | Vertebrae | | Fins | | | | Gill rakers | | Branchiostegals |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Precaudal (Total) | Caudal | Dorsal | Anal | Pectoral | Pelvic | Upper (Total) | Lower | |
| *Acantholiparis*[b] | Bering Sea | | | | | | Absent | | | 6 |
| *Acantholiparis caecus* | Oregon | 8-10 | 43-46 | 48-52 | 43-45 | 21 | Absent | (10-11) | | 6-7 |
| *Acantholiparis opercularis* | Calif.-Bering Sea | 9 | 41 | 45-52 | 38-47 | 20-24 | Absent | (8-10) | | 6 |
| *Careproctus abbreviatus* | SE Alaska-Bering Sea | | | 39 | 32 | 21 | Disc | | | 6 |
| *Careproctus attenuatus* | Bering Sea | | | 48 | 40 | 34 | Disc | | | 6 |
| *Careproctus bowersianus* | Bering Sea | 9-10 | 47-50 | 51-54 | 46-48 | 34-38 | Disc | | | 6 |
| *Careproctus cameliae* | Bering Sea | | | 50 | 45 | 28 | Disc | | | 6 |
| *Careproctus canus* | Aleutian Is. | 11-12 | 44-47 (55-58) | 51-53 | 43-46 | 33-36 | Disc | | | 6 |
| *Careproctus colletti* | Aleutian Is.-Bering Sea | (59-63) | | 52-58 | 47-52 | 25-31 | Disc | | | 6 |
| *Careproctus cypselurus* | Oregon-Bering Sea | 8 | 57-59 (64-70) | 58-64 | 52-58 | 32-37 | Disc | | | 6 |
| *Careproctus ectenes* | Aleutian Is.-Bering Sea | | | 48 | 44 | 30-32 | Disc | | | 6 |
| *Careproctus filamentosus* | Oregon | 9-10 | 54-58 (63-68) | 58-63 | 51-55 | 21-24 | Disc | | | 6 |
| *Careproctus furcellus* | Bering Sea | 10-11 | 56-61 (66-71) | 60-65 | 54-59 | 32-37 | Disc | | | 6 |
| *Careproctus gilberti* | Cent. Calif.-Bering Sea | 8-9 | 47-49 (55-58) | 45-55 | 41-48 | 30-33 | Disc | | | 6 |
| *Careproctus longifilis* | SSC-Oregon | 7-10 | 46-50 (55-58) | 50-54 | 44-48 | 17-23 | Disc | | | 6 |
| *Careproctus melanurus* | SSC-Bering Sea | 8-11 | 49-53 (57-63) | 53-58 | 47-51 | 27-33 | Disc | | | 6 |
| *Careproctus microstomus* | Oregon | 9-10 | 58-59 (67-69) | 61-67 | 54-60 | 22-27 | Disc | | | 6 |
| *Careproctus mollis* | Bering Sea | | | 51 | 47 | 35 | Disc | | | 6 |
| *Careproctus opisthotremus* | Aleutian Is.-Bering Sea | | | 46 | 36 | 32 | Disc | | | 6 |
| *Careproctus oregonensis* | Oregon | 8-10 | 57-60 (65-69) | 61-67 | 55-57 | 19-23 | Disc | | | 6 |
| *Careproctus ostentum* | Aleutian Is.-Bering Sea | | | 54 | 47 | 32 | Disc | | | 6 |
| *Careproctus ovigerum* | Oregon-Brit. Col. | 10-12 | 35-39 (47-49) | 43-45 | 34-37 | 31-34 | Disc | | | 6 |
| *Careproctus pellucidus* | SE Alaska | | | 52-55 | 45-48 | 33-35 | Disc | | | 6 |
| *Careproctus phasma* | Bering Sea | | | 53 | 45 | 34 | Disc | | | 6 |
| *Careproctus pycnosoma* | Bering Sea | 10 | 36-39 (46-49) | 42-45 | 36-39 | 38-39 | Disc | | | |
| *Careproctus rastrinus* | SE Alaska-Bering Sea | 8-9 | 50-52 (59-64) | 55-59 | 49-52 | 33-37 | Disc | | | 6 |
| *Careproctus scottae* | SE Alaska-Bering Sea | | | 52-56 | 47-51 | 32-34 | Disc | 2 | 10 | 6 |
| *Careproctus simus* | Aleutian Is.-Bering Sea | 10-11 | 48-52 | 54-58 | 47-51 | 31-37 | Disc | | | 6 |
| *Careproctus spectrum* | SE Alaska-Bering Sea | | | 52 | 47 | 32 | Disc | | | 6 |
| *Careproctus zachirus* | Aleutian Is. | 12-13 | 44-46 (56-58) | 51-58 | 43-45 | 28-31 | Disc | | | |
| *Crystallichthys cyclospilus* | Gulf of Alaska-Bering Sea | 11 | 42 (52-53) | 48-50 | 42-43 | 33-36 | ? | | | 6 |
| *Crystallichthys mirabilis* | Bering Sea | | | 53 | 44 | 30-33 | ? | | | 6 |
| *Elassodiscus caudatus* | Cent. Calif.-SE Alaska | 9-11 | 46-51 | 49-55 | 41-50 | 27-29 | Disc | | | 6 |
| *Elassodiscus tremebundus* | Bering Sea | 9-12 | 52-63 (62-74) | 55-67 | 49-60 | 25-33 | Disc | | | 6 |
| *Gyrinichthys minytremus* | Aleutian Is.-Bering Sea | | | 25 | 14 | 25 | Disc | | | 6 |
| *Liparis bristolensis* | Bering Sea-Chukchi Sea | (49) | | 38-40 | 30-35 | 33-37 | Disc | | | 6 |
| *Liparis callyodon* | Wash.-Bering Sea | (41-42) | | 33-35 | 25-27 | 28-31 | Disc | | | 6 |

**Table 41 (continued)**

| Taxon | Distribution | Vertebrae: Precaudal (Total) | Vertebrae: Caudal | Fins: Dorsal | Fins: Anal | Fins: Pectoral | Fins: Pelvic | Gill rakers: Upper (Total) | Gill rakers: Lower | Branchiostegals |
|---|---|---|---|---|---|---|---|---|---|---|
| *Liparis catharus* | SE Alaska | 12 | 38 | 46 | 36 | 37 | Disc | | | 6 |
| *Liparis cyclopus* | Oregon-Bering Sea | (42-44) | | 35-37 | 29-31 | 29-32 | Disc | | | 6 |
| *Liparis dennyi* | Wash.-Aleutian Is. | (44-45) | | 37-40 | 30-34 | 36-39 | Disc | | | 6 |
| *Liparis florae* | S. Calif.-Bering Sea | (39-40) | | 31-33 | 25-27 | 29-33 | Disc | 0-1 | 3-4 | |
| *Liparis fucensis* | Cent. Calif.-SE Alaska | 10-11 | 29-30 | 33-35 | 27-29 | 37-43 | Disc | (8-9) | | 6 |
| *Liparis gibbus* | SE Alaska-Arctic | 10-12 | 34-38 | 38-46 | 32-37 | 37-45 | Disc | (6-10) | | 6 |
| *Liparis grebnitzki* | Bering Sea | | | 32 | 27 | 29 | Disc | | | 6 |
| *Liparis mednius* | Bering Sea | | | 29[c] | 27 | 27 | Disc | | | 6 |
| *Liparis megacephalus* | Bering Sea | | | 43-44 | 36 | 36-38 | Disc | | | 6 |
| *Liparis micraspidophorus* | Aleutian Is.-Bering Sea | | | 31-32 | 25-27 | 30-32 | Disc | | | 6 |
| *Liparis mucosus* | SSC-SE Alaska | (36-38) | | 28-32 | 22-25 | 27-32 | Disc | | | 6 |
| *Liparis ochotensis* | Gulf of Alaska-Bering Sea | | | 45 | 36-38 | 39-42 | Disc | | | 6 |
| *Liparis pulchellus* | Cent. Calif.-Bering Sea | 11-12 | 40-42 | 47-53 | 39-42 | 36-37 | Disc | | 6-9 | 6 |
| *Liparis rutteri* | N. Calif.-Bering Sea | (37-39) | | 30-32 | 23-27 | 30-33 | Disc | | | 6 |
| *Liparis tunicatus* | Bering Sea-Arctic | 10-12 | 35-38 | 39-44 | 33-37 | 32-38 | Disc | | 5-11 | 6 |
| *Liparis cus nanus* | Cent. Calif.-SE Alaska | | | 40-52 | 37-49 | 13-15 | Disc | | | 5 |
| *Nectoliparis pelagicus* | Cent. Calif.-Bering Sea | 9-12 (61-64) | 50-52 | 44-56 | 40-51 | 19-25 | Absent | | | 5 |
| *Odontoliparis ferox* | Oregon | 11 | 48 | 51 | 46 | 17 | Absent | | | 6 |
| *Osteodiscus cascadiae* | Oregon-Brit. Col. | 8-9 (51-56) | 43-47 | 47-52 | 40-44 | 20-25 | Absent | | | 6 |
| *Paraliparis cephalus* | S. Calif.-Bering Sea | 9-10 | 47-54 | 50-57 | 44-51 | | Absent | | | 6 |
| *Paraliparis dactylosus* | Cent. Calif.-Bering Sea | (59-61) | | 54-56 | 49-51 | 28-30 | Absent | | | 6 |
| *Paraliparis deani* | N. Calif.-SE Alaska | | | 56-58 | 44-48 | 18-22 | Absent | | | 6 |
| *Paraliparis holomelas* | Bering Sea | | | 58-61 | 54 | 23 | Absent | | | 6 |
| *Paraliparis latifrons* | SSC-Oregon | 9-10 (61) | 51-52 | 54-57 | 48-50 | 21-24 | Absent | | | 6 |
| *Paraliparis megalopis* | Oregon | 9 (76) | 67 | 66-71 | 63-65 | 16-19 | Absent | | | 6 |
| *Paraliparis melanobranchus* | Oregon | | | 60 | 53 | 17 | Absent | | | 6 |
| *Paraliparis mento* | Cent. Calif.-Wash. | 9-10 | 51-52 | 55-59 | 49-51 | 16-18 | Absent | | | 6 |
| *Paraliparis paucidens* | Oregon-Brit. Col. | 10-12 (66-67) | 55-56 | 58-60 | 53-54 | 19-24 | Absent | | | 6 |
| *Paraliparis pectoralis* | Oregon-Bering Sea | 10-11 (61-64) | 51-54 | 55-58 | 49-52 | 28-32 | Absent | | | 6 |
| *Paraliparis rosaceus* | SSC-Brit. Col. | 11-13 (67-74) | 56-61 | 57-69 | 53-60 | 18-22 | Absent | | | 6 |
| *Paraliparis ulochir* | SSC-Bering Sea | 9-10 (72-74) | 62-65 | 65-69 | 60-64 | 21-24 | Absent | | | 6 |
| *Polypera beringiana* | Wash.-Bering Sea | | | 38-39 | 31-32 | 36-37 | Disc | | | 6 |
| *Polypera greeni* | Brit. Col.-Bering Sea | (47) | | 37-40 | 31-32 | 33-37 | Disc | | | 6 |
| *Rhinoliparis attenuatus* | Cent. Calif.-Bering Sea | (80-83) | | 74-78 | 70-73 | 21-25 | Absent | | | 6 |
| *Rhinoliparis barbulifer* | S. Calif.-Bering Sea | (68) | | 63-68 | 57-59 | 18-21 | Absent | | | 6 |
| *Temnocora candida* | Gulf of Alaska-Bering Sea | (68) | | 45-48 | 39 | 33-37 | Disc | | | 6 |

[a] The NWAFC meristic database was updated for the Liparidinae by the papers of Kido (1983, 1984, 1985), Kido and Kitagawa (1986), and unpublished data from D. Stein (Oregon St. Univ., Corvallis, OR 97331, pers. commun., 29 Oct. 1986).
[b] At least two undescribed species in addition to *A. opercularis* probably occur in the Bering Sea.
[c] According to Soldatov and Lindberg (1930), *Liparis mednius* has six dorsal spines.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 61-X-64 |
| | Precaudal: 9-X-12 |
| | Caudal: 50-X-52 |
| **Branchiostegal rays** | 5-5-5 |
| **Caudal fin** | |
| **Pelvic fin** | Absent |
| **Dorsal fin** | R: 44-X-56 |
| **Pectoral fin** | R: 19-20-25 |
| **Anal fin** | R: 40-X-51 |
| **Gill rakers** | U: X-X-X L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Cent. California, 34-38°N, to Bering Sea, 54-66°N |
| **Ecology** | Nearshore shelf demersal |
| **ELH pattern** | Oviparous, eggs probably demersal, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE[a]

**Preanal length** Changes with development
**Length at flexion**
**Length at transformation**
**Sequence of fin development**
**Pigment**

- Darkly pigmented peritoneum
- Ventral half of head pigmented, appearing bearded

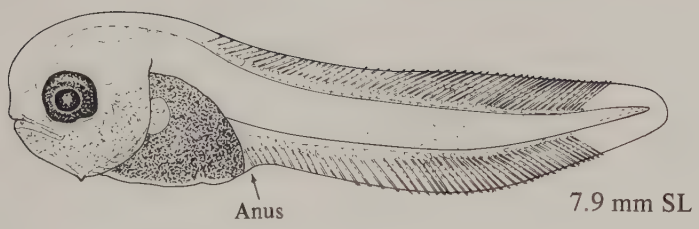
**Diagnostic characters**

- Presence of two separate pectoral fin lobes
- General tadpole shape
- Position of anus: Apparently moves forward with development; in adults anus is directly under eye
- Absence of disc
- Number of branchiostegal rays (five)

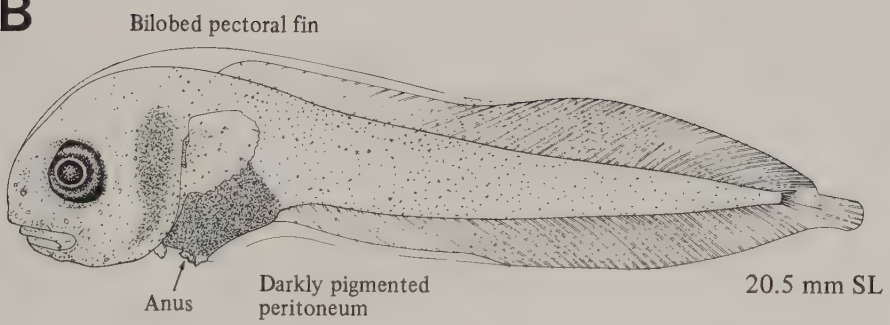
[a] Identification of small larvae prior to pectoral fin development and movement of anus forward is tentative. A cleared and stained 7.9-mm SL specimen has five branchiostegal rays.

Ref: Hart 1973.

A




B




Figures A–B, NWAFC originals (B. Vinter).

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: X-X-X | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Absent | |
| **Dorsal fin** | R: 56-X-58 | |
| **Pectoral fin** | R: 18-X-22 | |
| **Anal fin** | R: 44-X-48 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | N. California, 38-42°N, to SE Alaska, 55-59°N |
| **Ecology** | Epi-, meso-, and bathybenthal, 55-1008 m |
| **ELH pattern** | Oviparous; demersal, adhesive eggs; pelagic larvae |
| **Spawning** | Season: Continuous and periodic spawning occurs with other *Paraliparis* spp.[a] |
| | Area: Probably under rocks or in/on invertebrates with hard exoskeletons[a] |
| | Mode: Parental care (egg guarding) likely for periodic spawners[a] |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | ~2 mm |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE[b]

| | |
|---|---|
| **Preanal length** | |
| **Length at flexion** | |
| **Length at transformation** | |
| **Sequence of fin development** | |
| **Pigment** | |

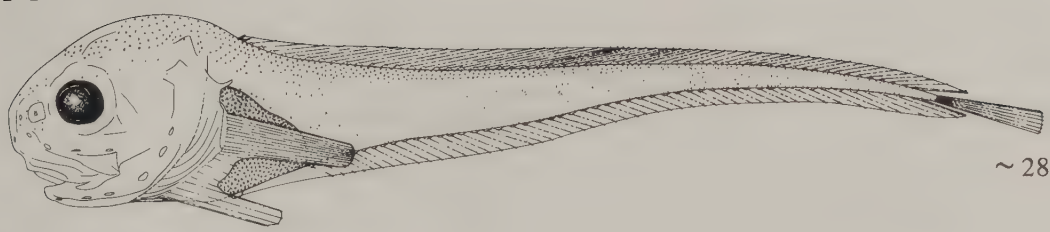
**Diagnostic characters**

- Characteristic notch in pectoral fin
- General body shape
- Absence of disc

[a] Stein 1980b
[b] Juvenile specimens only, probably *P. deani*.

Ref: Able et al. 1984, Hart 1973.

A



~ 28.5 mm SL

Figure A, NWAFC original (B. Vinter).

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 68-68-68 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | X, 3, X | |
| **Pelvic fin** | Absent | |
| **Dorsal fin** | S: 63-X-65 | R: X-X-X |
| **Pectoral fin** | R: 18-X-20 | |
| **Anal fin** | S: 57-X-59 | R: X-X-X |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Bering Sea, 54-66°N |
| **Ecology** | Meso- and bathybenthal |
| **ELH pattern** | Parity unknown, eggs probably demersal, benthopelagic larvae[a] |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 2.5 mm |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | ≤9.1 mm SL |
| **Incubation time/temp.** | |

**Pigment**

- Unpigmented

**Diagnostic characters**

- Yolk absorbed by 11.7 mm SL
- Flexion and fin ray development occurs prior to hatching

### LARVAE (postflexion and juvenile)

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | <9.1 mm SL |
| **Length at transformation** | |
| **Sequence of fin development** | Dorsal, anal, and caudal; pectoral |

**Pigment**

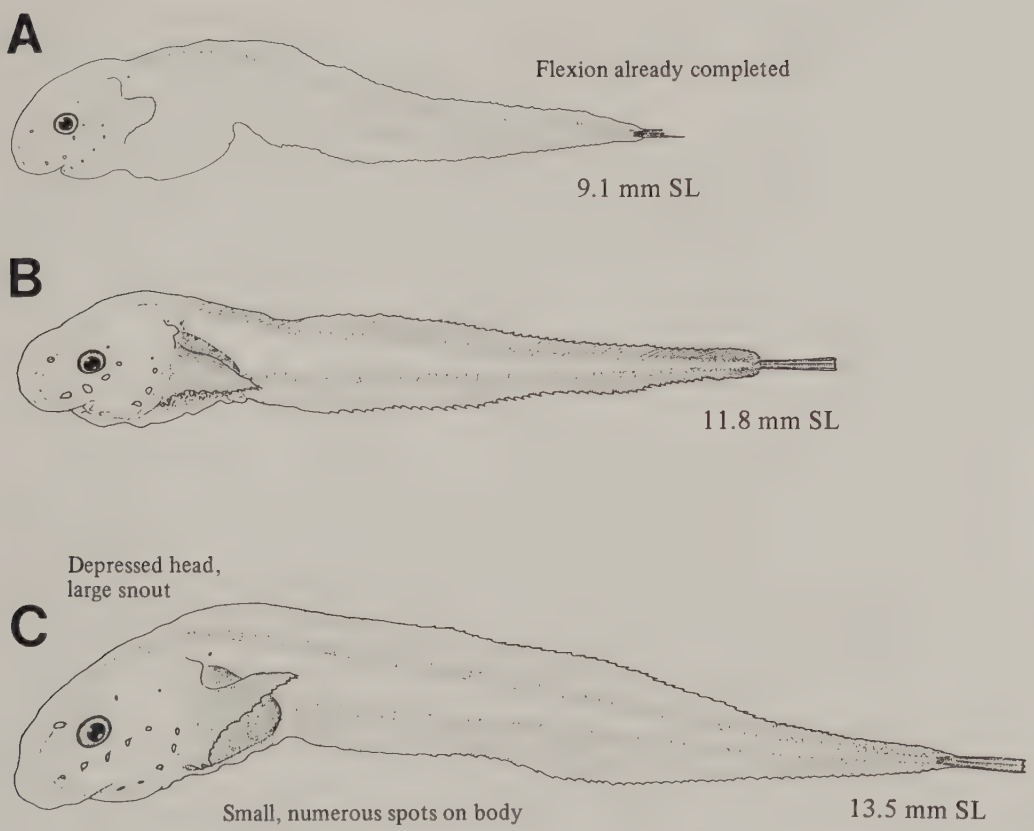
- Larvae <11.0 mm SL have no pigment
- Nape, peritoneum, and lateral body pigmented by 12.5 mm SL
- Pigment on the head and body increases in larger specimens

**Diagnostic characters**

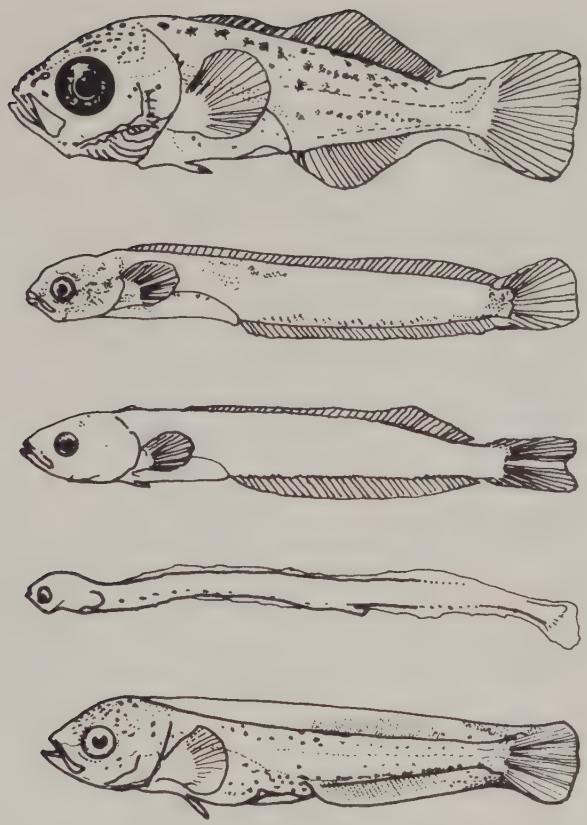
- Loose skin over body
- Morphology
  - —Depressed head
  - —Large snout
  - —Slender tapering body
- Absence of disc

[a] Kido and Kitagawa 1986

Ref: Able et al. 1984, Kido and Kitagawa 1986.




Figures A–C (A, yolksac larva; B–C, juveniles), Kido and Kitagawa 1986 (specimens from Iwate Prefecture, Honshu, Japan).



## Perciformes

The most diversified of all fish orders is the Perciformes. Although the order encompasses the entire range of fish forms and behavior, most species are adapted for life as predators in shallow or surface waters. More than a dozen characters (many secondarily lost) define this group of spiny-rayed fishes. Most obvious of these are fin spines, two dorsal fins, scales generally ctenoid, pelvic fin inserted forward of the abdomen, and vertical insertion of the pectoral fin. There are 22 suborders, 150 families, 1,367 genera, and about 7,800 species within the order (J. Nelson 1984). The most speciose groups are the percoids and zoarcoids. Within the study area, nine suborders are represented; four of them are composed of a single species. Most species are members of the families Stichaeidae and Zoarcidae.

Some early-life-history stages are known for most families within our area except for Zoarcidae and Scytalinidae. When describing the sequence of fin ray development for percoids, we used the patterns A-F summarized in G.D. Johnson (1984) (see also Introduction, p. 29). A summary of meristic characters of zoarcids is provided to assist in identification.

Families in study area:

**Carangidae**
**Bramidae**
**Caristiidae**
**Sciaenidae**
**Pentacerotidae**
**Bathymasteridae**
**Zoarcidae**
**Stichaeidae**
**Cryptacanthodidae**
**Pholididae**
**Anarhichantidae**
**Ptilichthyidae**
**Zaproridae**
**Scytalinidae**
**Trichodontidae**
**Clinidae**
**Icosteidae**
**Ammodytidae**
**Gobiidae**
**Trichiuridae**
**Scombridae**
**Luvaridae**
**Stromateidae**
**Centrolophidae**
**Tetragonuridae**

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 25-25-25 | |
| | Precaudal: 10-10-10 | |
| | Caudal: 15-15-15 | |
| **Branchiostegal rays** | 7-X-8 | |
| **Caudal fin** | 9-10, 9+8, 8-9 | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 5-5-5 |
| **Dorsal fin** | S: 4-X-7 | R: 24-X-29 |
| **Pectoral fin** | R: X-X-X | |
| **Anal fin** | S: 2-X-3[a] | R: 15-X-18 |
| **Gill rakers** | U: 5-X-8 | L: 12-X-19 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Brit. Col., 48°30′-55°N |
| **Ecology** | Epipelagic |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | ~1.3 mm |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | Smooth |
| **Hatch size** | |
| **Incubation time/temp.** | 24-48 hr/18-30°C |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | ~50-75% SL |
| **Length at flexion** | >4.1 mm SL |
| **Length at transformation** | |
| **Sequence of fin development** | "A" pattern:[b] 2nd dorsal (rays), anal, and caudal simultaneously followed by 1st dorsal (spines), pelvics, and pectorals (some carangids have precocious pelvics) |

**Pigment**

- Uniform heavy pigmentation
- Body: Dorsolateral, lateral midline, and scattered on ventrolateral
- Vomer and branchiostegal membrane
- Antimedial rows on dorsal body margin present or absent[c]

**Diagnostic characters**

- Relatively deep bodied
- Uniform heavy pigment except in caudal region
- Pigment on branchiostegal membrane
- 25 myomeres
- Flexion and postflexion
  - —Large posttemporal and supracleithral, supraocular and preopercular spines (not serrate)
  - —No supraoccipital crest

[a] The first two spines are physically separated from the third, shorter spine which is associated with the anal fin soft rays.
[b] G.D. Johnson 1984
[c] Laroche et al. 1984

Ref: Laroche et al. 1984, Sanzo 1931b.

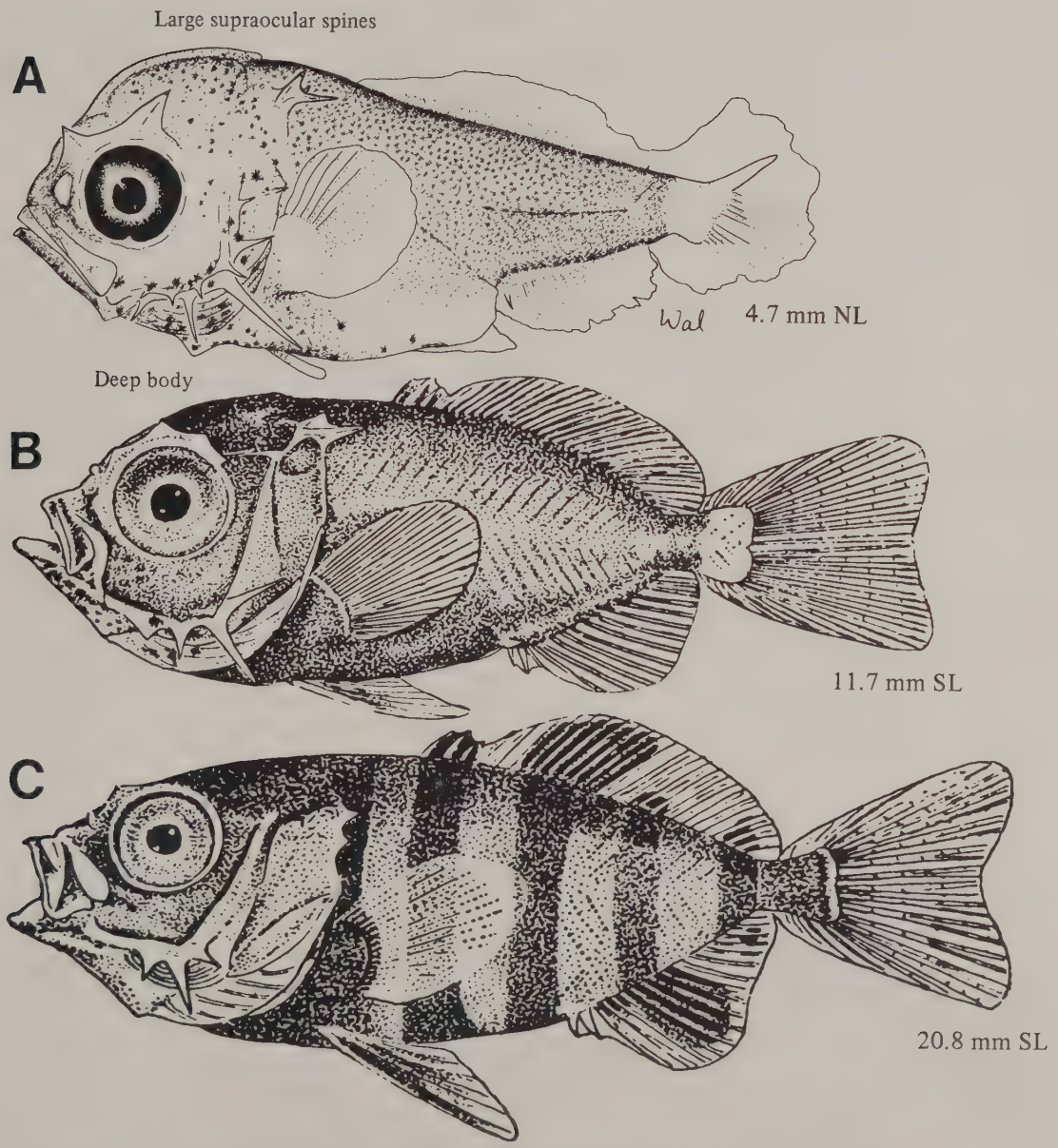



Figure A, Laroche et al. 1984 (Gulf of Mexico specimen); B–C, Sanzo 1931b (eastern Atlantic specimens).

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 23-24-25 | |
| | Precaudal: 10-10-10 | |
| | Caudal: 14-14-14 | |
| **Branchiostegal rays** | 7-X-8 | |
| **Caudal fin** | 9-10, 9+8, 9-10 | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 5-5-5 |
| **Dorsal fin** | S: 8-X-9 | R: 28-X-38 |
| **Pectoral fin** | R: X-X-X | |
| **Anal fin** | S: 2-X-3[a] | R: 22-X-33 |
| **Gill rakers** | U: 7-X-15 | L: 25-X-42 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Gulf of Alaska, 54-60°N |
| **Ecology** | Epi- and mesopelagic, 0-403 m[b] |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Jan-Nov;[c] Mar-Aug (California)[d] |
| | Area: Epipelagic, offshore[e] |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: 53,000[b] |
| **Age at first maturity** | 2-3 yr[e] |
| **Longevity** | >30 yr[e] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 0.90-1.08 mm |
| **No. of oil globules** | One |
| **Oil globule diameter** | 0.25 mm |
| **Yolk** | Segmented |
| **Envelope** | Smooth, clear |
| **Hatch size** | 1.91-2.38 mm SL |
| **Incubation time/temp.** | 24-48 hr/18-30°C |

**Pigment**

- Oil globule
- Dorsal and ventral melanophores

**Diagnostic characters**

- Anterior position of oil globule in yolksac larvae
- Pigment
- Lack of yolk pigment distinguishes eggs from *Merluccius productus* (p. 186) and *Scomber japonicus* (p. 554)

### LARVAE

| | |
|---|---|
| **Preanal length** | 52-61% SL[f] |
| **Length at flexion** | 8-11 mm SL |
| **Length at transformation** | 16 mm SL |
| **Sequence of fin development** | "A" pattern:[g] 2nd dorsal (rays), anal, and caudal simultaneously followed by 1st dorsal (spines), pelvics, and pectorals (some carangids have precocious pelvics) |

**Pigment**

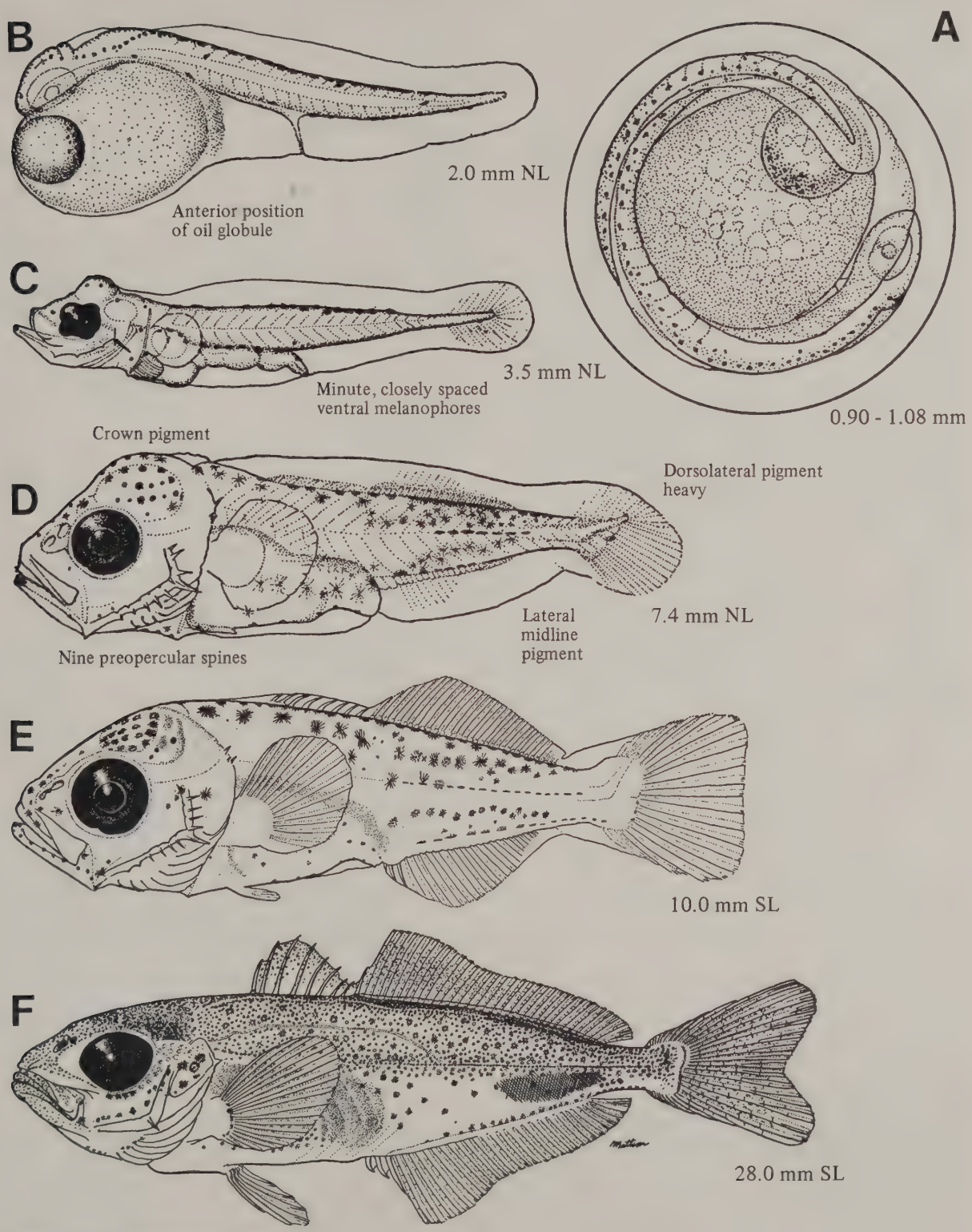
- Crown, dorsal and ventral midline
- Mediolateral streak
- Some superficial lateral pigment develops

**Diagnostic characters**

- Low myomere count (usually 24)
- Dorsal body margin pigment; antimedial rows absent with median rows only
- Flexion and postflexion
  —~9 preopercular spines (not serrate)
  —Supraoccipital crest present

[a] The first two spines are physically separated from the third, shorter spine which is associated with the anal fin soft rays.
[b] Hart 1973
[c] Frey 1971
[d] MacCall and Stauffer 1983
[e] Fitch and Lavenberg 1971
[f] Remains within this range from 2.2 to 50.0 mm SL.
[g] G.D. Johnson 1984

Ref: Ahlstrom and Ball 1954, Laroche et al. 1984.




Figures A–F, Ahlstrom and Ball 1954.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 39-40-41<br>Precaudal: 15-16-17<br>Caudal: 23-24-26 |
| **Branchiostegal rays** | 7-X-8 |
| **Caudal fin** | 8, 9+8, 7 |
| **Pelvic fin** | Thoracic<br>S: 1-1-1 R: 5-5-5 |
| **Dorsal fin**[a] | S: 3-3-5 R: 30-X-35<br>D1+D2=33-36 |
| **Pectoral fin** | R: 21-22-23 |
| **Anal fin**[a] | S: 2-X-3 R: 25-X-29<br>A1+A2=27-30 |
| **Gill rakers** | U: X-X-X L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Bering Sea, 54-66°N |
| **Ecology** | Epipelagic, 0-200 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Spring (California)[b]<br>Area: Pelagic[b]<br>Mode:<br>Migration: To the south to spawn[b] |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | >6 yr[b] |

[a] Since spines are weak or lacking in fins, there has been much confusion in the literature. According to data collected by G.D. Johnson (Natl. Mus. Nat. Hist., Wash., D.C., 20560, pers. commun., 7 Nov. 1986), all dorsal and anal elements are soft rays. Total counts from Mead (1972) are therefore more useful and are presented here.

[b] Fitch and Lavenberg 1971

[c] G.D. Johnson 1984

[d] G.D. Johnson, pers. commun., 7 Nov. 1986.

Ref: Mead 1972.

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.56-1.60 mm |
| **No. of oil globules** | One |
| **Oil globule diameter** | 0.40×0.32 mm |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | By 7.4 mm SL |
| **Length at transformation** | |
| **Sequence of fin development** | Both "C" and "D" patterns[c] described for the family are not present in this species[d] |

**Pigment**

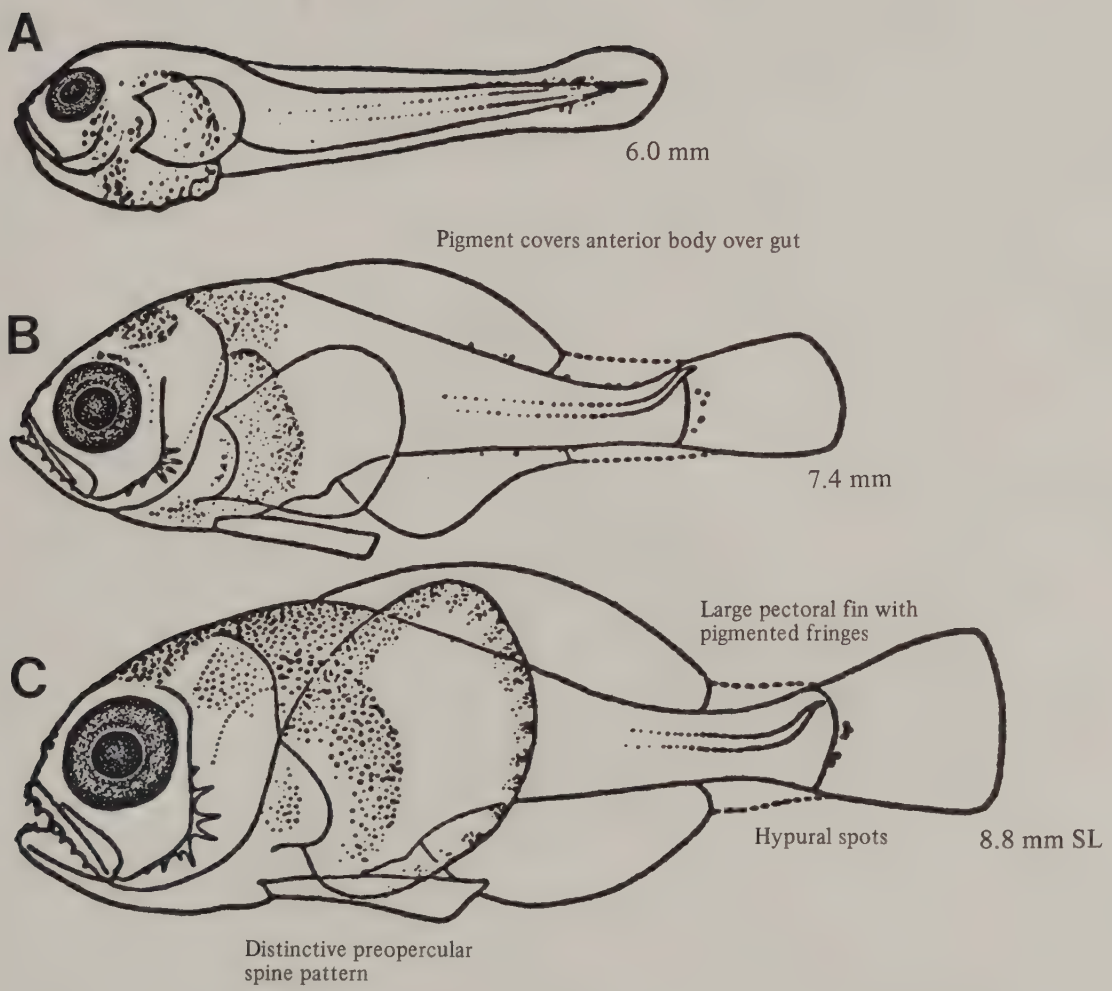
- Gut and anterior body
- Crown
- With development along hypural margin
- Pectoral fin fringes

**Diagnostic characters**

- Pigment covers anterior body
- Body depth: Deep upper body
- Large pectoral fin
- Patterns of preopercular spines are useful diagnostic characters for bramid larvae

*Taractes asper* larvae are unknown. The following information may aid in their identification.

| | |
|---|---|
| Total vertebrae | 41-42 |
| Caudal | 17-18 |
| Precaudal | 23-24 |
| Dorsal fin (D1+D2) | 31-34 |
| Anal fin (A1+A2) | 23-26 |
| Pectoral fin rays | 18-20 |
| Pelvic fin | I,5 |
| Range | Cent. Calif.-Gulf of Alaska |




Figures A–C, Mead 1972 (eyes redrawn).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 37-38-40<br>Precaudal: 16-16-16<br>Caudal: 19-19-19 |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | 6-7, 9+8, 6 |
| **Pelvic fin** | Thoracic<br>S: 1-1-1 R: 5-5-5 |
| **Dorsal fin**[a] | D1+D2=32-34 |
| **Pectoral fin** | R: 14-X-19 |
| **Anal fin**[a] | A1+A2=20-22 |
| **Gill rakers** | U: 6-6-6 L: 16-16-16 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Brit. Col., 48°30′-55°N |
| **Ecology** | Mesopelagic, 305-610 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season:<br>Area:<br>Mode:<br>Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | |
| **Length at flexion** | Between 5.8 and 10.1 mm SL |
| **Length at transformation** | |
| **Sequence of fin development** | "A" pattern:[b] 2nd dorsal (rays), anal, and caudal simultaneously followed by 1st dorsal (spines), pelvics, and pectorals |

**Pigment**
- Postanal bar pattern
- Head and mediolateral gut

**Diagnostic characters**
- Myomeres (>35)
- Distinct pigment pattern with bars
- Head and body shape

[a] There is confusion in the literature whether spines are present in the dorsal (1-3) and anal (1) fins. According to data collected by G.D. Johnson, all dorsal and anal elements are soft rays (Natl. Mus. Nat. Hist., Wash., D.C. 20560, pers. commun., 7 Nov. 1986). Total counts are therefore more useful and are presented here.
[b] G.D. Johnson 1984

Ref: G.D. Johnson 1984.

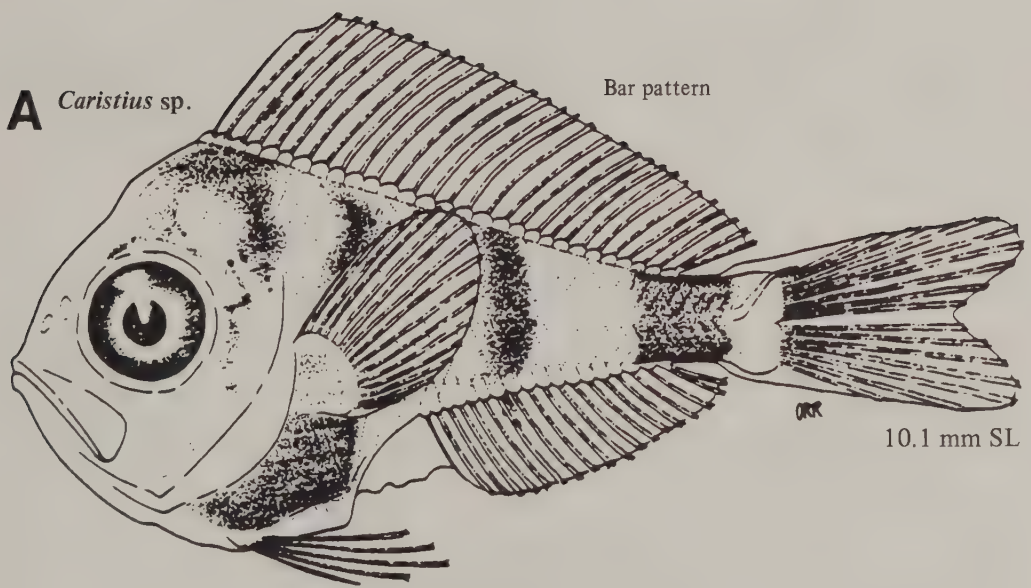



Figure A, G.D. Johnson 1984.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 26-26-26 | |
| | Precaudal: 10-11-12 | |
| | Caudal: 14-15-16 | |
| **Branchiostegal rays** | 7-X-8 | |
| **Caudal fin** | X, 9+8, X (15-17 secondary) | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 5-5-5 |
| **Dorsal fin** | S: 13-X-16 | R: 18-22-25 |
| **Pectoral fin** | R: 16-17-19 | |
| **Anal fin** | S: 2-2-2 | R: 10-11-12 |
| **Gill rakers** | U: 9-X-12 | L: 17-X-21 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Brit. Col., 48°30′-55°N |
| **Ecology** | Nearshore shelf pelagic |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Winter-spring[a] |
| | Area: Pelagic[b] |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 0.85 mm |
| **No. of oil globules** | 1-3, coalesce early to 1 |
| **Oil globule diameter** | 0.23 mm |
| **Yolk** | Homogeneous, becoming pigmented |
| **Envelope** | Transparent, smooth |
| **Hatch size** | 1.5-2.0 mm SL |
| **Incubation time/temp.** | 52 hr/20°C |

**Pigment**

- Yolk and oil globule
- Embryonic pigment increases on head and trunk (dorsally and dorsolaterally)

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Prenanal length** | 38-53% SL |
| **Length at flexion** | 5.4-6.4 mm SL |
| **Length at transformation** | >12.7 mm SL |
| **Sequence of fin development** | 2nd dorsal (rays), anal, 1st dorsal (spines), pelvics |

**Pigment**

- Presence of nape melanophore
- Melanophore above hindgut absent or small
- 2-21 ventral melanophores; number increasing with development

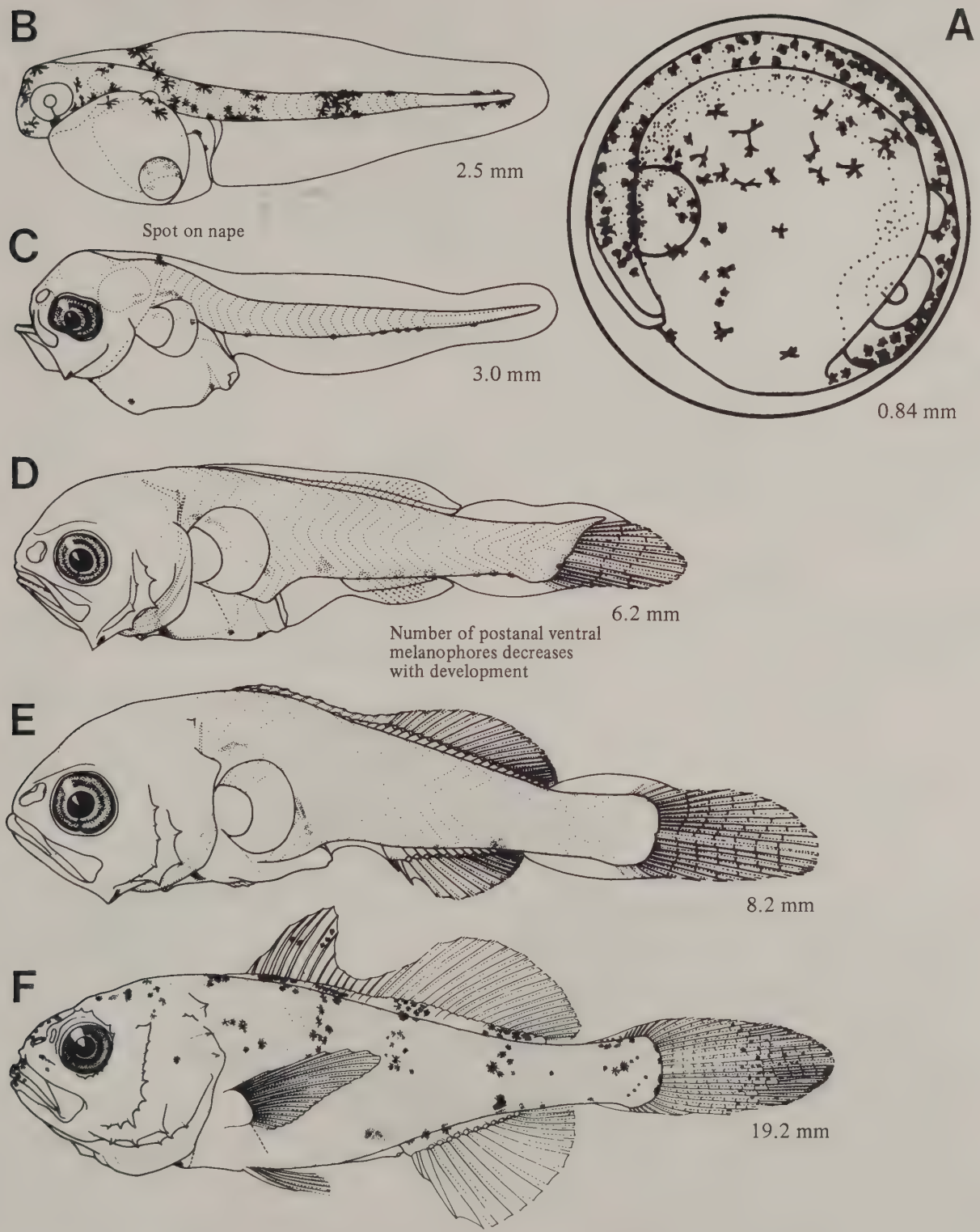
**Diagnostic characters**

Among the fish larvae occurring in the study area, *G. lineatus* most closely resembles *Scomber japonicus* (p. 554). The myomere counts will usually separate them.

| | |
|---|---|
| *G. lineatus* | 26 |
| *S. japonicus* | 30-31 |

[a] Hart 1973
[b] Watson 1982

Ref: Watson 1982.




Figures A–F, Watson 1982.

## MERISTICS[b]

| | | |
|---|---|---|
| **Vertebrae** | Total: 24-X-25 | |
| | Precaudal: 12-X-13 | |
| | Caudal: 13-13-13 | |
| **Branchiostegal rays** | 7-7-7 | |
| **Caudal fin** | 7, 9+8, 5-6 | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 5-5-5 |
| **Dorsal fin** | S: 13-X-15 | R: 8-X-10 |
| **Pectoral fin** | R: 16-X-19 | |
| **Anal fin** | S: 3-4-5 | R: 6-X-9 |
| **Gill rakers** | U: 5-X-8 | L: 14-X-20 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | N. California, 38-42°N, to Gulf of Alaska, 54-60°N |
| **Ecology** | Epi- and mesopelagic, 0-402 m |
| **ELH pattern** | Oviparous, pelagic eggs, larvae probably pelagic[c] |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

**Preanal length**
**Length at flexion** <9 mm SL
**Length at transformation**
**Sequence of fin development**

**Pigment** (early juvenile *P. richardsoni*)

- Entire body heavily pigmented with intense patches along dorsal body midline and on spinous dorsal, anal, and pelvic fins

**Diagnostic characters** (early juvenile *P. richardsoni*)

- Pigment pattern
- Bony cranial projections, spines by 10-16 mm SL; most prominent are the following: median supraoccipital; posttemporal; lateral expansions which develop over orbit, becoming highly serrated along the edge with development; preopercular
- Anteriorly serrated pelvic spine
- With development there is a reduction in spination

[a] *Pentaceros* = *Pseudopentaceros* (Hardy 1983). J. Nelson (1984) does not recognize the genus *Pseudopentaceros* and cites Smith (1964) who included *Pseudopentaceros* in the synonomy of *Pentaceros*. Hardy (1983) removed *Pseudopentaceros* from synonomy but his work is not cited in J. Nelson (1984). The genus *Pseudopentaceros* may include up to three species:

*Pseudopentaceros richardsoni*—Restricted to Southern Hemisphere
*P. wheeleri*—North Pacific Ocean from Japan to Hawaii
*P. pectoralis*—North Pacific, Hawaii to Aleutian Is. (overlaps with *P. wheeleri* in central Pacific)

Hardy (1983) describes *P. wheeleri* as the most slender form. He suggests they are the "slender forms" referred to by Zama et al. (1977a) in their description of *Pentaceros richardsoni*. Hardy does not synonomize their "high-bodied" forms with *P. wheeleri*. The juvenile form described by Zama et al. (1977a) may include *P. wheeleri* in part. Hardy (1983) names this species as the one targeted on the Hawaiian ridge for intense commercial fishing. *Pseudopentaceros wheeleri* and *P. pectoralis* are probably the same species at different ontogenetic stages. Most likely two species occur worldwide (Humphreys et al. 1989).

[b] Hardy 1983; includes meristic data for *Pseudopentaceros richardsoni*, *P. pectoralis*, and *P. wheeleri*.

[c] Juveniles collected at surface to at least 260 mm FL; the shift from pelagic to bottom life may be ambivalent, occurring between 260 and 300 mm FL.

Ref: Hardy 1983, Humphreys et al. 1989, G.D. Johnson 1984, Zama et al. 1977b.

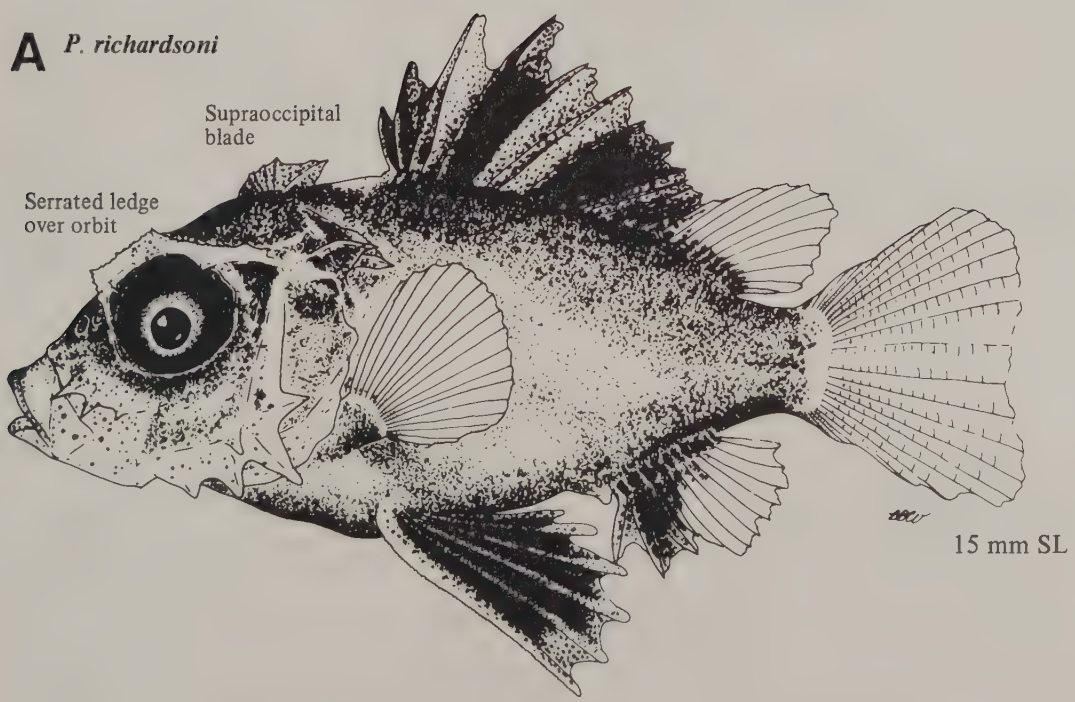



Figure A, G.D. Johnson 1984 (southern hemisphere specimen).

# BATHYMASTERIDAE

This endemic North Pacific family occurs throughout the study area where four species from two genera are found. Ronquils are elongate with long dorsal and anal fins composed almost entirely of soft rays. Little is known of the adult habits in the family except for some members of the genus *Rathbunella*, occurring from south of Point Conception to northern California, which inhabit rocky areas 10-92 m deep (and are occasionally taken with trawl nets). Courtship of *Rathbunella* is paired and may result in spawning occurring over a protracted period of time. Demersal eggs, which measure 0.9-1.1 mm and contain one oil globule, are deposited in a nonadhesive mass that is guarded by the male (Fitch and Lavenberg 1975, NWAFC unpubl.).

Pelagic larvae of *Ronquilus jordani* are collected in ichthyoplankton surveys conducted off Alaska and along the Pacific coast to northern California. *Bathymaster* spp. (6-40 mm SL) are routinely collected in the Gulf of Alaska and in the Bering Sea. *Ronquilus* larvae can be separated from *Bathymaster* larvae by their lack of pigment around the urostyle. *Bathymaster* spp. larvae are presently not identifiable to species. Meristic characters offer some potential for larger larvae (e.g., *B. signatus* usually has higher counts, especially vertebrae and total caudal fin rays). Before their fin rays develop, bathymasterid larvae may often be confused with stichaeid larvae. Most stichaeids (except members of the Stichaeini tribe) have a myomere count >55, whereas bathymasterids have a count <55. *Ronquilus jordani* larvae (myomeres 49-50) most closely resemble *Stichaeus punctatus* larvae (myomeres 51-55) due to the presence of distinctive lateral pigment along the hypaxial myomeres. *Bathymaster* spp. larvae (myomeres 49-55) most closely resemble those of *Bryozoichthys-Chirolophis* (myomeres about 60-75) due to the presence of pigment around the urostyle.

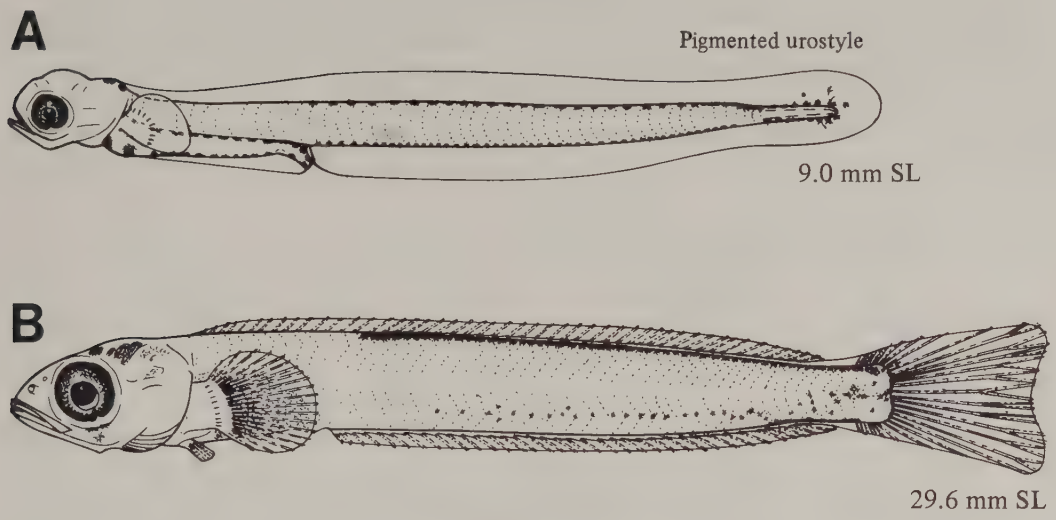
**Table 42**

**Meristic characters of family Bathymasteridae.[a] All have pelvic fin counts of I,5, 7+7 principal caudal fin rays, and 6 branchiostegal rays.**

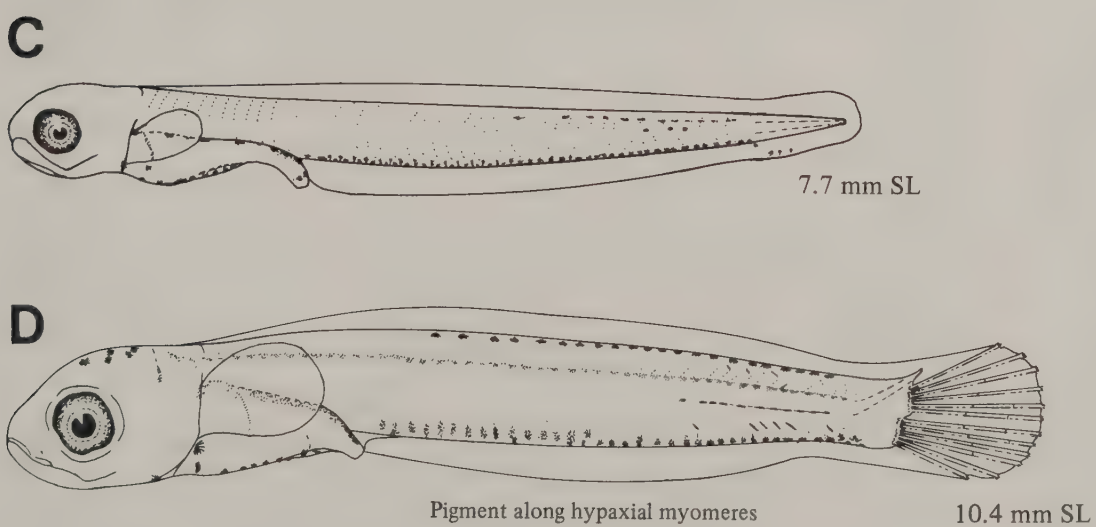
| | | Vertebrae | | Fins | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Caudal | | Gill rakers | |
| Taxon | Distribution | Precaudal | Caudal (Total) | Dorsal[b] | Anal[b] | Pectoral | Upper | Lower | Upper | Lower |
| *Bathymaster caeruleofasciatus* | Brit. Col.-Bering Sea | 14-15-16 | 35-38-39 (50-53-53) | 44-47-48 | 33-35-36 | 16-18-19 | | | 5 | 12-14 |
| *Bathymaster leurolepis* | Gulf of Alaska-Bering Sea | 14-15-15 | 35-36-37 (49-51-52) | 45-46-47 | 32-34-34 | 17-18-19 | 10 | 10 | 4-5 | 12-14 |
| *Bathymaster signatus* | Wash.-Arctic | 15-16-16 | 34-37-39 (54-54-55) | 46-48-49 | 33-34-36 | 19-20-21 | 10-12 | 9-11 | | 15-18 |
| *Ronquilus jordani* | N. Calif.-Bering Sea | 13-14-15 | 34-36-37 (49-50-50) | 44-45-46 | 33-35-35 | 17-17-19 | 5-7 | 5-7 | | |

[a] For some characters modal values are listed between range of values.
[b] Total counts include weak anterior spines; *Bathymaster* spp. usually possess two dorsal spines and one anal spine, and *Ronquilus* usually has one dorsal and one anal spine.

*Bathymaster* A




*Ronquilus jordani*




Figures A–D, NWAFC originals (B. Vinter).

Eelpouts are found chiefly in colder marine waters of the Northern Hemisphere. They have elongate, tapered bodies with long dorsal and anal fins confluent with the caudal fin. The pelvic fins are small and jugular when present. The head is large and the mouth is often big with thick lips. Within the study area there are 48 species within 14 genera. Adults are found from the intertidal zone to depths of more than 1900 m (Hart 1973). Although members of the genus *Zoarces* are viviparous, all species in our area, where reproductive mode is known, are oviparous. Oviparous species have been observed guarding their eggs by wrapping themselves around the egg mass. Demersal eggs are adhesive, spherical, and possess one oil globule. Diameters range from 1.7 to 9.0 mm. Newly hatched larvae are quite advanced and strongly resemble adult zoarcids (Anderson 1984b). Larvae of only five taxa have been illustrated; four are from outside the study area. Larvae probably become demersal or semidemersal soon after hatching because they are virtually never collected in plankton nets.

**Table 43**

**Meristic characters of family Zoarcidae (taxonomy after Anderson 1984a,b).**

| | | Vertebrae | | Fins | | | | Gill rakers | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Taxon | Distribution | Precaudal (Total) | Caudal | Dorsal | Anal | Pectoral | Pelvic[a] | Upper (Total) | Lower | Branchiostegals |
| *Bothrocara brunneum* | SSC-Bering Sea | 22 | 94 | 107-112 | 92-96 | 14-17 | ab | 3-5 | 14-15 | |
| *Bothrocara hollandi* | Bering Sea | | | 114-117 | 94-99 | 15-17 | ab | 4 | 11 | 6 |
| *Bothrocara molle* | SSC-Bering Sea | (120) | | 100-112 | 89-101 | 13-14 | ab | (22) | | |
| *Bothrocara pusillum* | SE Alaska-Brit. Col. | 18-20 | 95-101 | 113-121 | 100-107 | 14-17 | ab | | | |
| *Bothrocara remigerum* | Cent. Calif.-Wash. | 23 | 96 | 107-117 | 93-94 | 13-16 | | | | |
| | | (116) | | | | | | | | |
| *Derepodichthys alepidotus* | SSC-Brit. Col. | 22-26 | 92-98 | 110-116 | 94-101 | 10-11 | 3 | 0-1 | 11-12 | 6 |
| *Gymnelis hemifasciatus* | Gulf of Alaska-Arctic | 18-21 | 65-77 | 80-92[b] | | | | | | |
| | | (85-95) | | | | | | | | |
| *Gymnelis popovi* | Gulf of Alaska-Bering Sea | | | 101 | 89 | | ab | 3 | 12 | |
| *Gymnelis viridis* | Aleutian Is.-Arctic | (87-99) | | 92-93 | 74 | 10-12 | ab | | | |
| *Krusensterniella pavlovskii* | Bering Sea | 20-21 | 88-89 | 70-75 | | 12 | ab | | | |
| *Lycenchelys altus* | Aleutian Is. | 21 | 67 | 83 | 68 | 18 | | 1 | 7 | |
| | | (88) | | | | | | (8) | | |
| *Lycenchelys camchaticus* | SSC-Bering Sea | 21-24 | 97-103 | 112-117 | 98-105 | 13-17 | | 2 | 13-16 | 6 |
| | | | | | | | | (14-18) | | |
| *Lycenchelys crotalinus* | S. Calif.-Bering Sea | 22-24 | 98-107 | 113-123 | 99-109 | 14-17 | | 1 | 14-18 | 6 |
| *Lycenchelys hippopotamus* | Bering Sea | 23-24 | 109-113 | | | 13-17 | | 3 | 12-14 | 6 |
| *Lycenchelys jordani* | Calif.-SE Alaska | 22-24 | 100-109 | 116 | 93 | 15-17 | | 1 | 15-18 | 6 |
| *Lycenchelys longirostris* | Bering Sea | 21-22 | 92-93 | 108-109 | 93-95 | 15-16 | | (9-11) | | |
| | | (113-115) | | | | | | | | |
| *Lycenchelys microporus* | Bering Sea | 29 | 94 | | | 18 | | 2 | 10 | 6 |
| *Lycenchelys pliciferus* | Bering Sea | 28-29 | 96-97 | | | 15 | | | | 6 |
| *Lycenchelys rassi* | Bering Sea | 23-25 | 98-103 | 119 | 104 | 15-16 | | 1-2 | 8-11 | 6 |
| *Lycenchelys ratmanovi* | Bering Sea | 22-23 | 88-89 | | | 16-19 | | 1-2 | 7-9 | 6 |
| *Lycenchelys roseus* | Aleutian Is. | 28 | 118-119 | 130-133 | 114-115 | 14-15 | | 1-2 | 9-10 | |
| *Lycenchelys volki* | Bering Sea | 30 | 96 | | | 17 | | 2 | 14 | 6 |
| *Lycodapus derjugini* | Bering Sea | 14-15 | 56-59 | 70-79 | 57-68 | 6-7 | ab | | | 6 |
| *Lycodapus dermatinus* | SSC-SE Alaska | 13-15 | 62-68 | 70-75 | 62-66 | 6-7 | ab | | | 6 |
| *Lycodapus endemoscotus* | SSC-Brit. Col. | 14-17 | 72-79 | 84-91 | 74-81 | 6-8 | ab | | | 6 |
| *Lycodapus fierasfer* | SSC-Bering Sea | 13-15 | 69-77 | 78-85 | 68-74 | 6-8 | ab | | | 6 |
| *Lycodapus leptus* | Bering Sea | 16-19 | 78-82 | 91-94 | | 6-8 | ab | | | 6 |
| *Lycodapus mandibularis* | S. Calif.-Bering Sea | 14-17 | 67-80 | 76-90 | 65-79 | 6-9 | ab | | | 6 |
| *Lycodapus pachysoma* | Oregon-Brit. Col. | 14-16 | 60-63 | 70-74 | 58-64 | 7-8 | ab | | | 6 |
| *Lycodapus parviceps* | Wash.-Bering Sea | 18-20 | 81-85 | 94-98 | | 8-9 | ab | | | 6 |
| *Lycodapus poecilus* | Bering Sea | 15-17 | 65-72 | 75-83 | | 5-7 | ab | | | 6 |
| *Lycodapus psarosomatus* | Bering Sea | 17-19 | 77-82 | 89-93 | | 8 | ab | | | 6 |
| *Lycodes brevipes* | Oregon-Bering Sea | 20-22 | 80-82 | 85-102 | 74-89 | 19-21 | 3 | 2-3 | 11 | |
| *Lycodes concolor* | Bering Sea | 22 | 92-93 | 47-118 | 98-99 | 21 | | 0-2 | 12 | |
| *Lycodes cortezianus* | S. Calif.-SE Alaska | 22-24 | 83-90 | 112-114 | 95-97 | 18-21 | 3 | 2 | 11 | 6 |
| *Lycodes diapterus* | S. Calif.-Bering Sea | 21-23 | 100 | 90-124 | 94-107 | 18-25 | 3 | 1 | 13 | |
| *Lycodes mucosus* | Bering Sea-Arctic | (90-92) | | 88-93 | 69-73 | 17-18 | | | | |
| *Lycodes pacifica* | SSC-Gulf of Alaska | 21-23 | 79-85 | 90-107 | 70-90 | 16-19 | 3 | 0-2 | 8-12 | |
| *Lycodes palearis* | Oregon-Chukchi Sea | (96-105) | | 94-106 | 83-90 | 17 | 3 | 2-3 | 10 | |
| *Lycodes raridens* | Bering Sea-Arctic | (97) | | 83-93 | 72-76 | 18-19 | | 3 | 10-12 | |
| *Lycodes turneri* | Bering Sea-Arctic | (90-100) | | 89-97 | 69-78 | 15-18 | 3 | | | |
| *Lyconema barbatum*[c] | SSC-Bering Sea | 20-21 | 86-93 | 101-105 | 90-94 | 15 | | 2 | 8-9 | |
| *Melanostigma pammelas* | SSC-Brit. Col. | 19-20 | 69-72 | 73-88 | 64-75 | 6-8 | ab | (11-13) | | 6-7 |
| *Nalbantichthys elongatus*[c] | Bering Sea | 25 | 119-125 | 143-152 | 121-127 | 6 | ab | | | 7 |
| *Opaeophacus acrogeneius*[c,d] | Bering Sea | 25-26 | | 141-148 | 121-124 | 4-5 | ab | 3 | 11 | 6 |
| | | (144-149) | | | | | | | | |
| *Pachycara bulbiceps* | SSC-Brit. Col. | | | 109 | 89 | 16 | ab | | | 6 |
| *Puzanovia rubra*[c] | Bering Sea | 22-24 | 110-125 | 137-147 | 115-128 | 10-12 | ab | 3-5 | 9-13 | 6 |
| *Taranetzella lycoderma*[c] | Oregon-Bering Sea | 19-20 | 69-78 | 84-91 | 71-79 | 15 | 3 | 3 | 13 | |
| | | (90-97) | | | | | | | | |

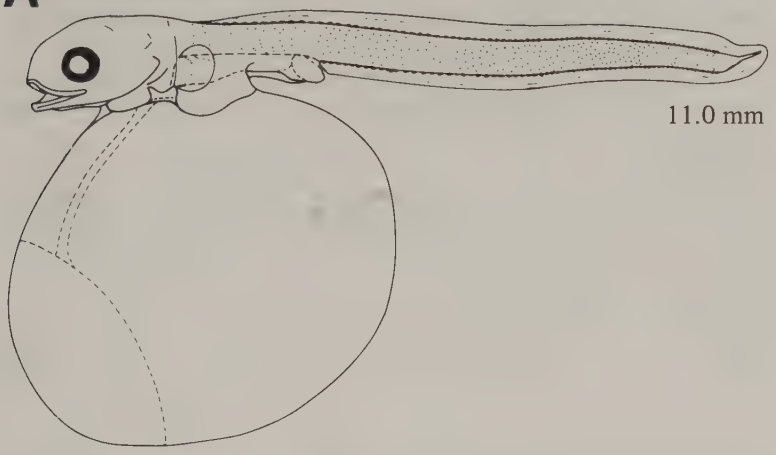
[a] ab = absent.

[b] Dorsal fin count does not include one spine.

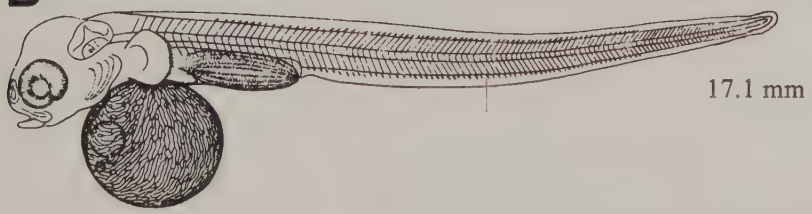
[c] Total principal caudal fin ray counts available for only the following species: *Lyconema barbatum*, 12; *Nalbantichthys elongatus*, 7-10; *Opaeophacus acrogeneius*, 8-9; *Puzanovia rubra*, 9-12; *Taranetzella lycoderma*, 8.

[d] Bond and Stein 1984

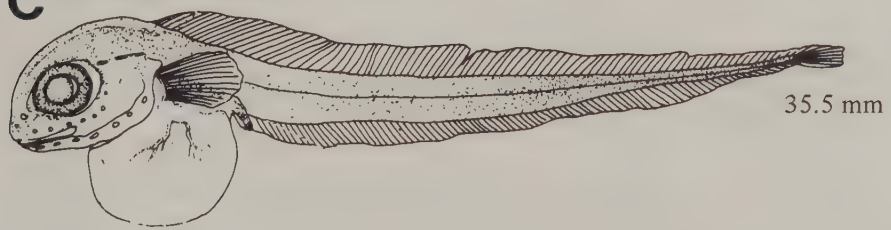
**A** Unidentified zoarcid



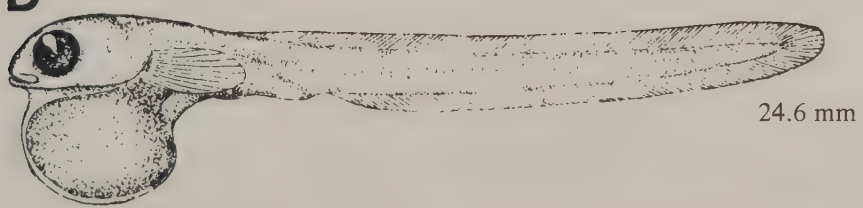

**B** *Zoarces viviparous*



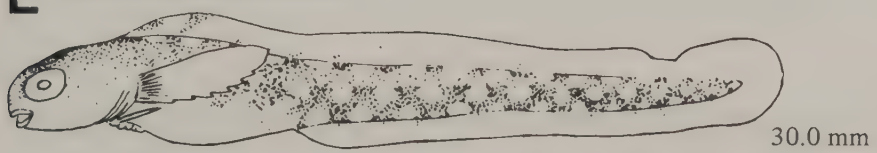

**C** *Bothrocara hollandi*




**D** *Gymnelus viridis*




**E** *Macrozoarces americanus*




Figures A–E, Kendall et al. 1983 (B, collected from Gulf of Riga, Baltic Sea; C, Japan Sea specimen; D, Barents Sea specimen; E, collected near New Brunswick).

# STICHAEIDAE

Pricklebacks are found mostly in the North Pacific in inshore areas. Adults are long and somewhat eel-like with a long dorsal fin composed of all spines in most species. Seventeen genera and 26 species are found in the study area. This family is separated into eight tribes grouped within four subfamilies. Six tribes within three subfamilies occur in our area.[1] Larvae are abundant in the area but very few larval series have been described. Before fin rays develop, small larvae are elongate and resemble other elongate forms, especially bathymasterids and pholidids (see Table 4). In general, bathymasterids have fewer myomeres and pholidids have a longer gut and more myomeres. Since so few complete larval series are available, general characters based on only a few species are presented for each tribe.

## Stichaeinae

Adult characters include: Pelvic fins I,3-4
(*Gymnoclinus* I,2)
Large pectoral fins
Vertebrae 49-76

### Stichaeini

Genera found within the study area: *Eumesogrammus* (one species) and *Stichaeus* (one species). Myomere counts are low (<55). *Stichaeus* larvae are identified by the distinctive lateral pigment along the hypaxial myomeres.

### Chirolophini

Genera found within the study area: *Bryozoichthys* (two species), *Chirolophis* (four species), and *Gymnoclinus* (one species). Myomere counts are >55. Larvae are generally more pigmented than Stichaeini. Melanophores occur along the dorsal and ventral body midline, over the notochord internally, and, in some taxa, around the urostyle.

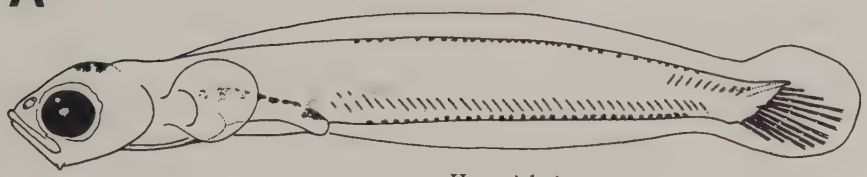
[1]Makushok (1958) places the genera *Eulophias* and *Azygopterus* in separate tribes under Xiphisterinae. Anderson (1984b) places them together in the Eulophiini. Other nomenclatural changes not affecting taxa in the study area are presented by Yatsu (1986).

Ref: Anderson 1984a,b; Makushok 1958.

## STICHAEINI

*Stichaeus punctatus*

A



Hypaxial pigment

13.5 mm TL

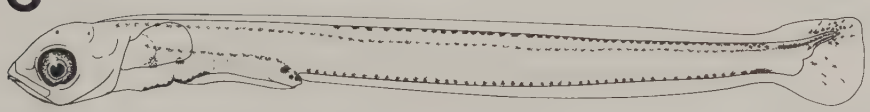
B

13.5 mm TL

## CHIROLOPHINI

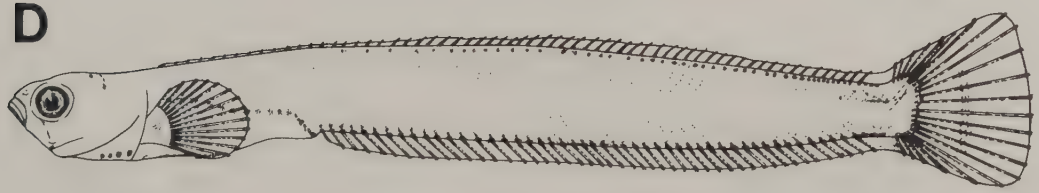
*Bryozoichthys–Chirolophis*

C



16.5 mm SL

D



29.0 mm SL

Figures A–B (B, ventral view), Fahay 1983 (after Faber 1976, North Atlantic specimen); C–D, NWAFC originals (B. Vinter).

## Lumpeninae

Adult characters include: Pelvic fins I,3 or absent
Large pectoral fins
Vertebrae 60-81

### Lumpenini

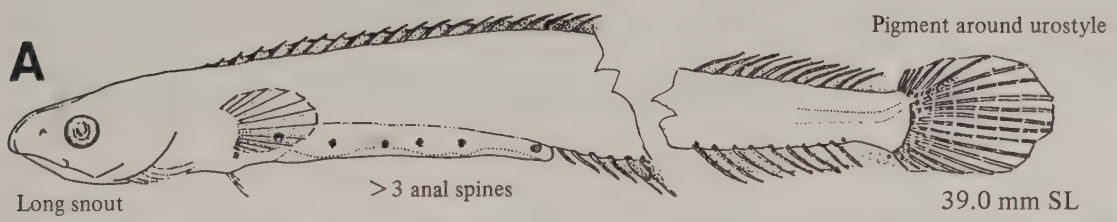
Genera found within the study area: *Acantholumpenus* (one species), *Anisarchus* (one species), *Lumpenella* (one species), *Lumpenus* (four species), and *Poroclinus* (one species). Lumpenini larvae generally lack pigment along the dorsal midline. Diagnostic pigment usually occurs over the dorsal surface of the gut and anus, along the ventral midline, and in the hypural area.

*Lumpenella* larvae generally have >70 myomeres and pigment around the urostyle, and, with development, can be identified by their distinctive snout and the presence of up to five anal spines. *Lumpenus* spp. larvae can be identified by meristics, number of postanal ventral melanophores, and number of melanophores on the anus. Hypural pigment is usually restricted to several spots along the posterior edge of the hypural area. *Poroclinus* larvae have distinctive pigment occurring above and below the notochord in the caudal peduncle area. They can also be distinguished from other Lumpenini by the presence of three anal spines.

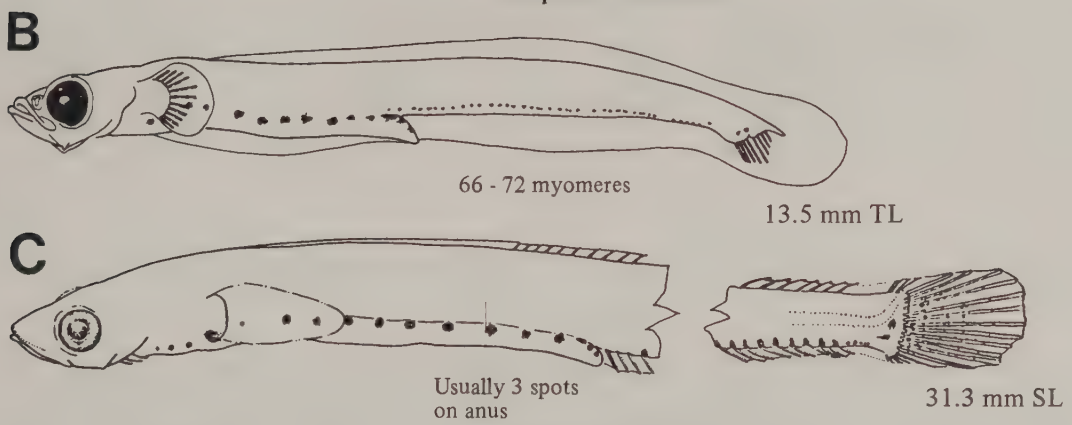
Ref: Anderson 1984a,b; Makushok 1958.

## LUMPENINI

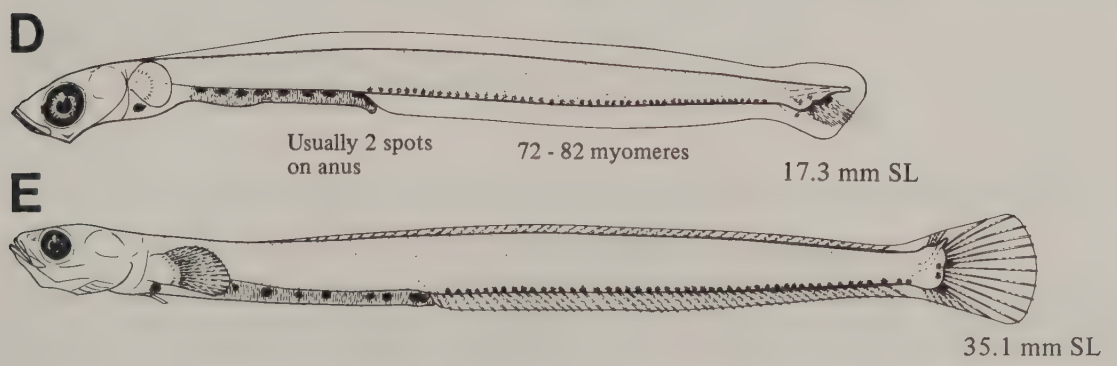
*Lumpenella longirostris*



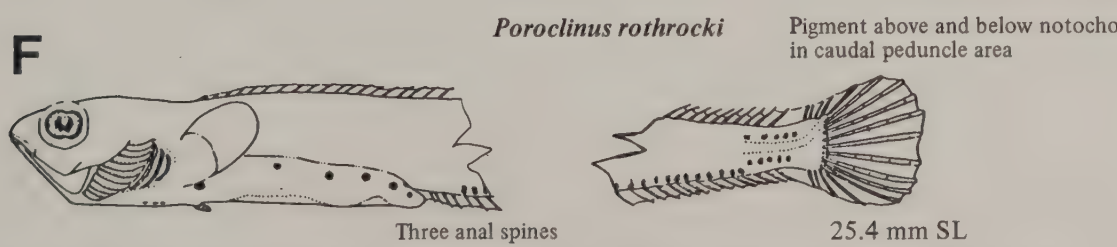

*Lumpenus maculatus*




*Lumpenus sagitta*




*Poroclinus rothrocki*




Figures A, C, F, Garrison, unpubl.; B, Fahay 1983 (after Faber 1976, Atlantic specimen); D–E, NWAFC originals (B. Vinter).

### Opisthocentrini

Genera found within the study area: *Allolumpenus* (one species), *Opisthocentrus* (one species), and *Plectobranchus* (one species). Larvae are known only for *Opisthocentrus* and *Plectobranchus*. *Plectobranchus* larvae have a distinctive pigment pattern quite dissimilar to *Opisthocentrus* (see species pages). *Opisthocentrus* larvae appear to resemble Alectrini larvae (e.g., similar pigment pattern and lack of pelvic fins).

## Xiphisterinae

Adult characters include: Pelvic fins absent
Pectoral fins small
Vertebrae 57-84

### Alectrini

Genera found within the study area: *Alectridium* (one species) and *Anoplarchus* (two species). Only larvae of *Anoplarchus purpurescens* are known from our area. They have a row of postanal ventral midline melanophores and a few spots along the hypural margin. No single unique character distinguishes them from Xiphisterini larvae but usually a combination of characters allows identification. These characters include fewer myomeres (58-68 vs. generally >70), smaller relative eye diameter, fewer melanophores dorsally on gut, and presence of hypural spots throughout the larval period (see species pages).

### Xiphisterini

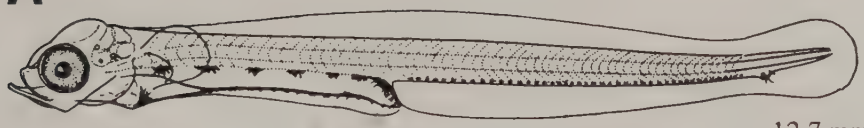
Genera found within the study area: *Cebidichthys* (one species), *Phytichthys* (one species), and *Xiphister* (two species). Although series of *Phytichthys* and *Xiphister* have been described, larvae are difficult to distinguish from one another and from *Anoplarchus*. Xiphisterini larvae usually have a row of postanal ventral melanophores and a row of internal pigment above the notochord.

Ref: Anderson 1984a,b; Makushok 1958.

OPISTHOCENTRINI

*Opisthocentrus ocellatus*

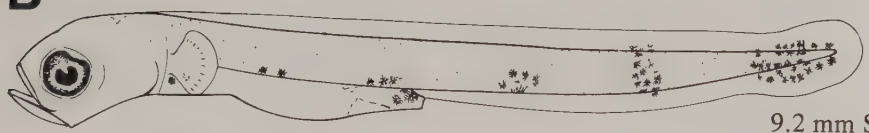
A



12.7 mm TL

*Plectobranchus evides*

B

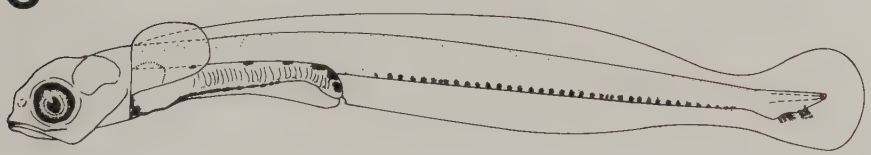


9.2 mm SL

ALECTRINI

*Anoplarchus purpurescens*

C

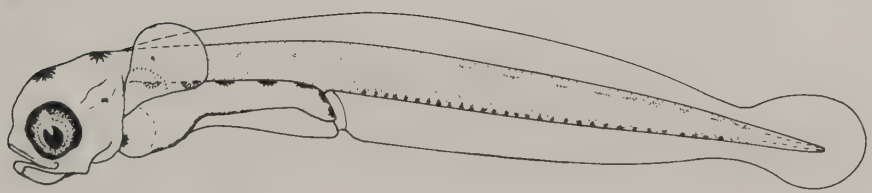


9.0 mm SL

XIPHISTERINI

*Xiphister atropurpureus*

D



8.0 mm SL

Figure A, Shiogaki 1982 (reared from Japanese specimens); B–D, NWAFC originals (B. Vinter).

## Table 44
**Meristic characters of family Stichaeidae.**

| Taxon | Distribution | Vertebrae: Precaudal (Total) | Vertebrae: Caudal (Total) | Fins: Dorsal | Fins: Anal | Fins: Pectoral | Fins: Pelvic[a] | Gill rakers: Upper | Gill rakers: Lower | Branchiostegals |
|---|---|---|---|---|---|---|---|---|---|---|
| **STICHAEINAE** | | | | | | | | | | |
| **Stichaeini** | | | | | | | | | | |
| *Eumesogrammus praecisus* | Bering Sea-Arctic | 15-16 | 34-36 (50-52) | XLVII-XLIX | II,31-33 | 18 | I,3 | | | 6 |
| *Stichaeus punctatus* | Brit. Col.-Arctic | 14-16 | 36-40 (51-55) | XLVI-XLIX | I-II,32-35 | 15-16 | I,4 | | | 6 |
| **Chirolophini** | | | | | | | | | | |
| *Bryozoichthys lysimus* | Aleutian Is.-Bering Sea | 16-17 | 53-54 | LXIII-LXVI | I,49-50 | 14-15 | I,3 | 4-5 | 9-11 | 6 |
| *Bryozoichthys marjorius* | Brit. Col.-Aleutian Is. | 15-17 | 56-59 (72-75) | LXII-LXXI | I,51-59 | 14-16 | I,3 | 5-6 | 9-10 | 6 |
| *Chirolophis decoratus* | N. Calif.-Bering Sea | | | LXI-LXIII | I,44-51 | 14-15 | I,4 | | | 6 |
| *Chirolophis nugator* | S. Calif.-Aleutian Is. | | | LIII-LV | I,37-42 | 13-14 | I,4 | | | 6 |
| *Chirolophis snyderi* | Bering Sea | 16-17 | 46-49 (63-65) | LVIII-LXI | I,43-45 | 15 | I,4 | | | 6 |
| *Chirolophis tarsodes* | Brit. Col.-Bering Sea | | | LVIII-LX | I,43-45 | 14-15 | I,3-4 | | | 6 |
| *Gymnoclinus cristulatus* | Bering Sea | | | LXI | 40-43 | 14 | I,1-2 | | | 6 |
| **LUMPENINAE** | | | | | | | | | | |
| **Lumpenini** | | | | | | | | | | |
| *Acantholumpenus mackayi* | Bering Sea | 27-29 | 49-52 (76-80) | LXVIII-LXXV | II,41-47 | 14-15 | I,3 | | | 6 |
| *Anisarchus medius* | SE Alaska-Arctic | | | | | | | | | |
| *Lumpenella longirostris*[b] | Brit. Col.-Gulf of Alaska | 24-25 | 47-49 | LXI-LXXI | II-V,36-42 | 13-14 | I,2-3 | | | 6 |
| *Lumpenus fabricii*[b] | SE Alaska-Arctic | 26-28 | 44-48 (70-75) | LXI-LXV | I,40-43 | 13-16 | I,3 | | | 6 |
| *Lumpenus maculatus*[b] | Wash.-Arctic | 26-30 | 39-43 (66-72) | LVII-LXIV | I-II,34-40 | 14-16 | I,3-4 | | | 6 |
| *Lumpenus medius* | SE Alaska-Arctic | 23-25 | 43-50 (65-70) | LVIII-LXIII | I,37-42 | | I,3 | | | 6 |
| *Lumpenus sagitta*[b] | N. Calif.-Bering Sea | 26-28 | 46-54 | LXIV-LXXII | I,45-50 | 15-17 | I,3-4 | | | 6 |
| *Poroclinus rothrocki* | S. Calif.-Bering Sea | | (65) | LVII-LXVII | III,40-44 | 13-15 | I,3[c] | | | 6 |
| **Opisthocentrini** | | | | | | | | | | |
| *Allolumpenus hypochromus* | S. Calif.-Brit. Col. | | | XLIV-XLIX | I,31 | 12 | I,3 | | | 6 |
| *Opisthocentrus ocellatus* | Bering Sea | 22-23 | 40-44 (63-67) | LVIII-LXII | II,37-39 | 20-21 | ab | | | 5 |
| *Plectobranchus evides*[b] | S. Calif.-Brit. Col. | | (60) | LIV-LVII | II-III,34-36 | 15 | I,3 | | | 5-6 |
| **XIPHISTERINAE** | | | | | | | | | | |
| **Alectrini** | | | | | | | | | | |
| *Alectridium aurantiacum* | Bering Sea | 19-21 | 46-48 (65-68) | LIX-LXIII | I,41-44 | 11 | ab | | | 5 |
| *Anoplarchus insignis* | N. Calif.-Aleutian Is. | 17-19 | 44-49 | LVII-LXIV | 40-46 | 9-10 | ab | | | 5 |
| *Anoplarchus purpurescens* | S. Calif.-Bering Sea | 17-19 | 40-46 (58-64) | LIV-LX | I,36-41 | 9-10 | ab | 3-5 | 5-10 | 5 |
| **Xiphisterini** | | | | | | | | | | |
| *Cebidichthys violaceus* | SSC-Oregon | 23-25 | 40-47 (65-71) | XXII-XXV, 40-43 | I-II,39-42 | 10-11 | ab | 3-4 | 6-10 | 6 |
| *Phytichthys chirus*[b] | S. Calif.-Bering Sea | 24-25 | 50-52 (75-76) | LXIX-LXXVIII | II-III,40-50 | 15 | ab | | | 6 |
| *Xiphister atropurpureus*[b] | SSC-Bering Sea | 22-24 | 51-56 (75-80) | LXV-LXXII | I,49-55 | 11-12 | ab | 2-3 | 6-10 | 6 |
| *Xiphister mucosus*[b] | Cent. Calif.-SE Alaska | 29-31 | 44-53 (73-83) | LXXI-LXXVIII | I,46-50 | 12 | ab | | | 6 |

[a] ab = absent.

[b] Principal caudal fin ray counts available for only the following species: *Lumpenella longirostris*, 6+6-7; *Lumpenus fabricii*, 6+7; *Lumpenus maculatus*, 7+6; *Lumpenus sagitta*, 6+7; *Plectobranchus evides*, 6+5; *Phytichthys chirus*, 6+7; *Xiphister atropurpureus*, 6+7; *Xiphister mucosus*, 6+7.

[c] Rudimentary.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 63-X-67 | |
| | Precaudal: 22-X-23 | |
| | Caudal: 40-X-44 | |
| **Branchiostegal rays** | 5-5-5 | |
| **Caudal fin** | | |
| **Pelvic fin** | Absent | |
| **Dorsal fin** | S: 58-X-62 | |
| **Pectoral fin** | R: 20-X-21 | |
| **Anal fin** | S: 2-2-2 | R: 37-X-39 |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Bering Sea, 54-66°N |
| **Ecology** | Nearshore shelf demersal |
| **ELH pattern** | Oviparous; demersal, adhesive eggs; pelagic larvae |
| **Spawning** | Season: Dec-Jan (Mutsu Bay, Japan)[a] |
| | Area: Narrow cavities under stones on muddy sand bottoms[a] |
| | Mode: Eggs spawned in masses and guarded by female[a] |
| | Migration: |
| **Fecundity** | Range/function: 700-3300[a] |
| **Age at first maturity** | 1 yr[a] |
| **Longevity** | 2-3 yr[a] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.89-2.01 mm |
| **No. of oil globules** | One large, many small (yellow) |
| **Oil globule diameter** | |
| **Yolk** | Colorless |
| **Envelope** | |
| **Hatch size** | 9-10 mm SL |
| **Incubation time/temp.** | 48 d/5-10°C |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | |
| **Length at transformation** | 33-40 mm SL[b] |
| **Sequence of fin development** | |

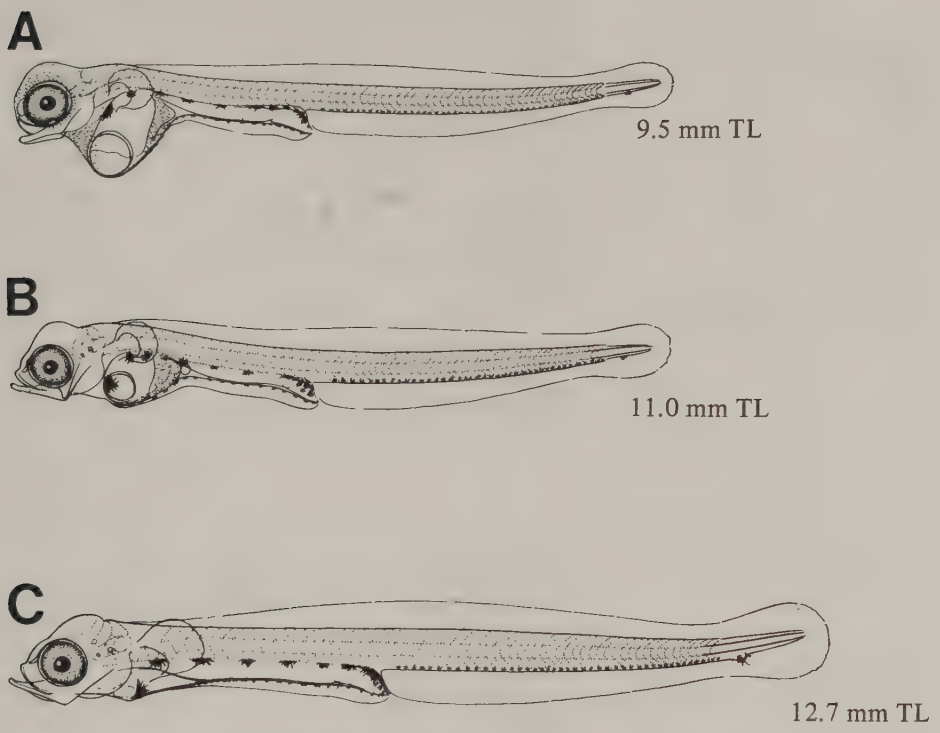
**Pigment**

- Dorsally and ventrally on gut
- Postanal ventral melanophores
- Hypural spot

**Diagnostic characters**

[a] Shiogaki 1982
[b] Collected with a small trawl net.

Ref: Shiogaki 1982.



Figures A–D, Shiogaki 1982 (A–C, reared from specimens collected from Mutsu Bay, Japan; D, collected from Mutsu Bay, Japan-probably newly settled).

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 60-60-60 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 5-X-6 | |
| **Caudal fin** | X, 6+5, X | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 3-3-3 |
| **Dorsal fin** | S: 54-X-57 | |
| **Pectoral fin** | R: 15-15-15 | |
| **Anal fin** | S: 2-X-3 | R: 34-X-36 |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Brit. Col., 48°30′-55°N |
| **Ecology** | Epi- and mesobenthal, 84-274 m |
| **ELH pattern** | Probably oviparous, eggs probably demersal, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE[a]

| | |
|---|---|
| **Preanal length** | ~50% SL |
| **Length at flexion** | Between 10 and 16 mm SL |
| **Length at transformation** | |
| **Sequence of fin development** | |

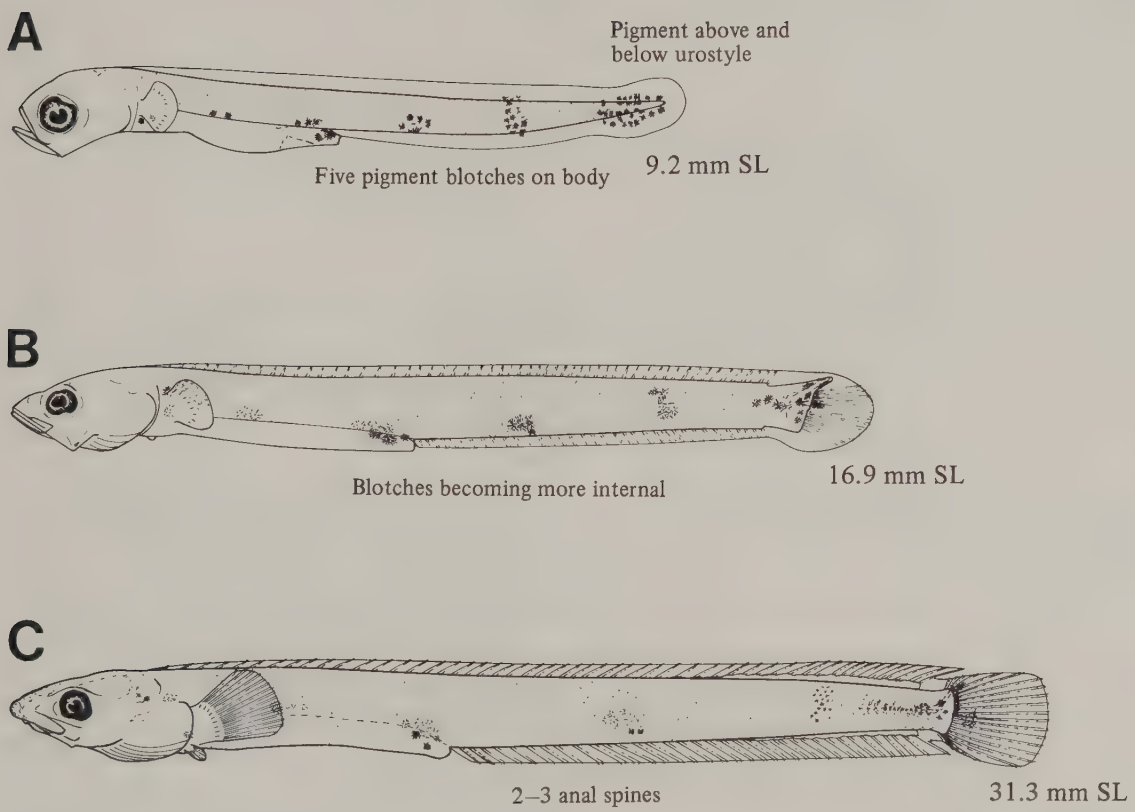
**Pigment**

- Blotch medially over gut near cleithrum
- Blotches on ventral body at midgut, hindgut over anus, and at myomeres 30 and 45
- Pigment becomes more internal in larger specimens
- Above and below notochord, increasing with development anteriorly in area where hypurals form

**Diagnostic characters**

- Pigment pattern: Five blotches along body
- Meristics: anal spines 2-3
  pelvic fin I,3

[a] Larvae obtained from Bruce Mundy, formerly of Oregon State University (present address, NMFS Southwest Fish. Cent., Honolulu Lab., 2570 Dole St., Honolulu, HI 96822-2396); originally identified by S.L. Richardson (deceased).




Figures A–C, NWAFC originals (B. Vinter).

# *Anoplarchus purpurescens* Gill 1861

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 58-60-64 | |
| | Precaudal: 17-18-19 | |
| | Caudal: 40-43-46 | |
| **Branchiostegal rays** | 5-5-5 | |
| **Caudal fin** | | |
| **Pelvic fin** | Absent | |
| **Dorsal fin** | S: 54-X-60 | |
| **Pectoral fin** | R: 9-X-10 | |
| **Anal fin** | S: 1-1-1 | R: 36-39-41 |
| **Gill rakers** | U: 3-X-5 | L: 5-X-10 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Bering Sea, 54-66°N |
| **Ecology** | Nearshore shelf demersal, intertidal to 30 m |
| **ELH pattern** | Oviparous; demersal, adhesive, attached eggs; pelagic larvae |
| **Spawning** | Season: Jan[a]-Mar[b]<br>Area: Demersal, under rocks or on shells[a]<br>Mode: Pairs; eggs laid in masses;[c] females guard nests[d]<br>Migration: |
| **Fecundity** | Range/function: 2000-3000[d] |
| **Age at first maturity** | 2-3 yr[d] |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.27-1.45 mm |
| **No. of oil globules** | 1-3, with development 1 large and 1 small |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | White |
| **Hatch size** | ~7.5 mm TL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

- Eggs laid in pedestal-shaped mass (flattened with lateral constriction)[c]

### LARVAE

| | |
|---|---|
| **Preanal length** | 40-45% SL |
| **Length at flexion** | ~10 mm SL |
| **Length at transformation** | ~12 mm SL |
| **Sequence of fin development** | |

**Pigment**

- Postanal ventral midline: A melanophore on nearly every myoseptum, at base of each anal fin ray
- A few melanophores at caudal fin base along hypural margin
- Dorsal and ventral gut pigment: Dorsally about five spots on posterior half, ventrally a continuous line on anterior 2/3 of gut
- Heavy uniform superficial body pigment on larvae >12 mm SL (early juveniles)

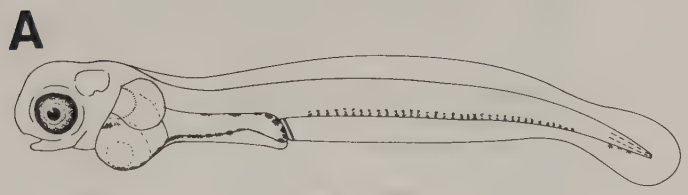
**Diagnostic characters**

Distinguished from *Xiphister* spp. (p. 516, 518) and *Phytichthys chirus* (p. 514) by

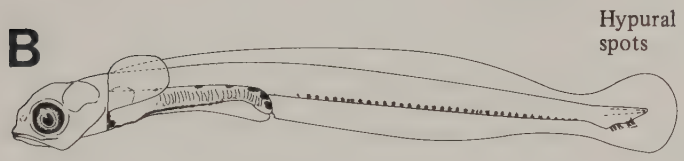
- Smaller relative eye diameter
- Fewer dorsal gut melanophores (<8)
- Hypural spots throughout larval period

[a] Marliave 1975a
[b] Schultz and DeLacy 1932
[c] J. Marliave, Vancouver Public Aquarium, P.O. Box 3232, Vancouver, B.C., Canada V6B 3X8, pers. commun., 16 Oct. 1986.
[d] Peppar 1965

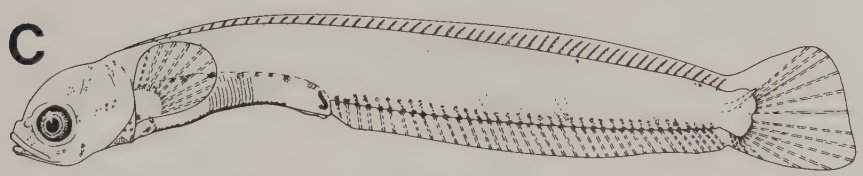
Ref: Marliave 1975a, Peppar 1965, Schultz and DeLacy 1932.



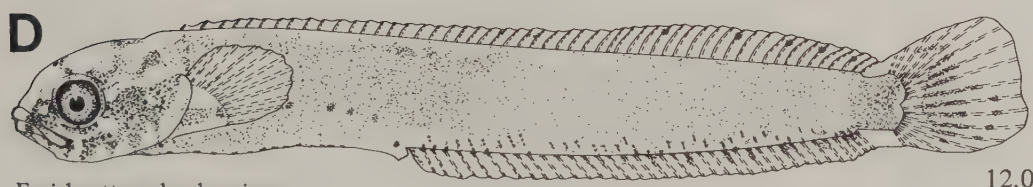

6.1 mm SL




9.0 mm SL

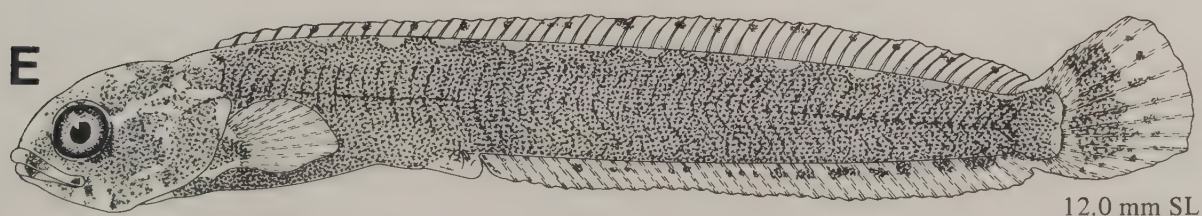



12.0 mm SL




12.0 mm SL

Facial pattern develops in
larvae approaching settlement




12.0 mm SL

Figures A–E, NWAFC originals (B. Vinter, reared).

# *Phytichthys chirus* (Jordan and Gilbert 1880)

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 75-X-76 | |
| | Precaudal: 24-X-25 | |
| | Caudal: 50-X-52 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | X, 6+7, X | |
| **Pelvic fin** | Absent | |
| **Dorsal fin** | S: 69-X-78 | |
| **Pectoral fin** | R: 15-15-15 | |
| **Anal fin** | S: 2-X-3 | R: 40-X-50 |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Bering Sea, 54-66°N |
| **Ecology** | Intertidal, nearshore shelf demersal |
| **ELH pattern** | Oviparous; demersal, adhesive eggs; pelagic larvae |
| **Spawning** | Season: Mid-winter (Brit. Col.)[a]<br>Area: Exposed intertidal, under rocks[a]<br>Mode: Pairs; single parent guards[a]<br>Migration: |
| **Fecundity** | Range/function: 1100 (one mass)[a] |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION[a]

### EGGS

| | |
|---|---|
| **Diameter** | 2.25 mm |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | White |
| **Hatch size** | 11.2 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

- Eggs laid in conical-shaped mass

### LARVAE

| | |
|---|---|
| **Preanal length** | 45% SL |
| **Length at flexion** | 13 mm SL |
| **Length at transformation** | 18-21 mm SL |
| **Sequence of fin development** | Caudal, dorsal and anal, pectorals |

**Pigment**

- Postanal ventral midline with about 30 spots
- Dorsally about eight spots on gut; ventral pigment present (not shown on figure)
- Row of internal pigment over notochord

**Diagnostic characters**

Distinguished from *Xiphister* spp. (p. 516, 518) by

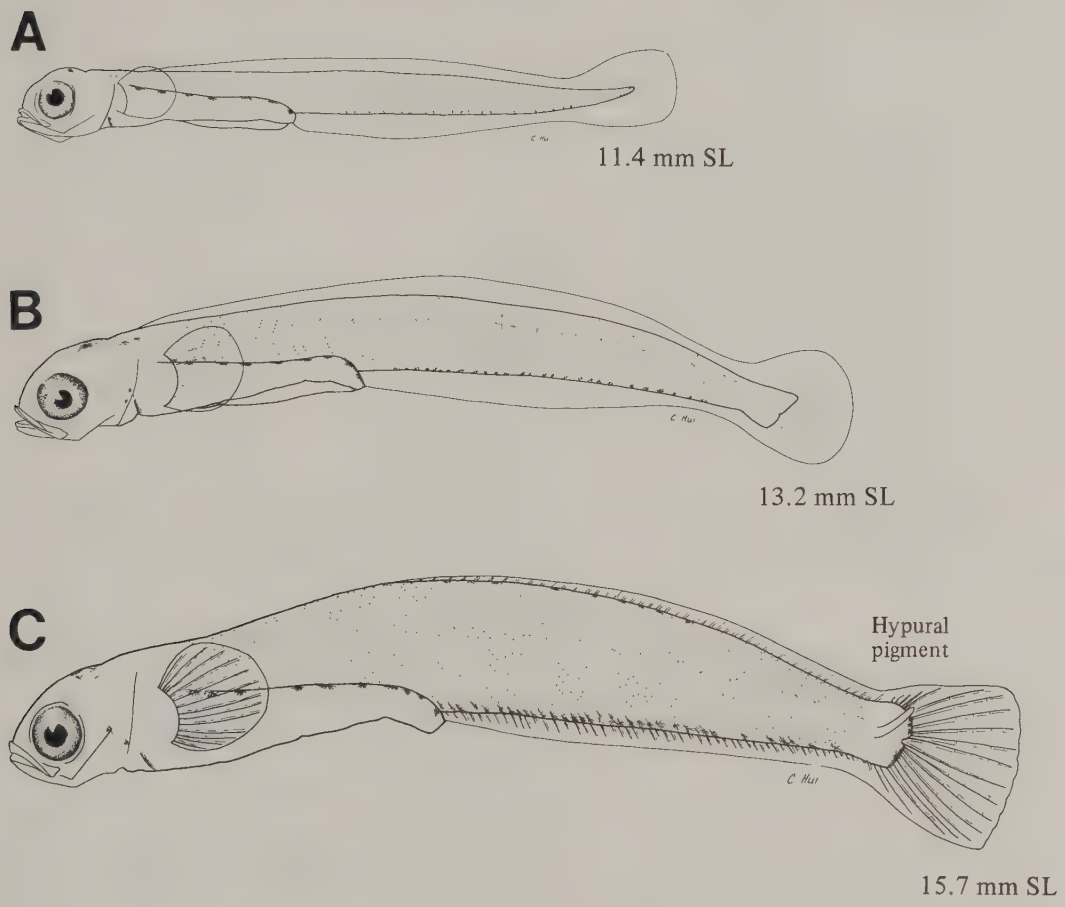
- Relatively larger at comparable stages of development (e.g., hatching occurs >10.0 mm SL)
- Larger relative eye diameter
- Dorsal body midline unpigmented in preflexion and flexion larvae

Distinguished from *Anoplarchus purpurescens* (p. 512) by

- Lack of hypural spots in preflexion and flexion larvae

[a] J. Marliave, Vancouver Public Aquarium, P.O. Box 3232, Vancouver, B.C., Canada V6B 3X8, pers. commun., 16 Oct. 1986. Drawings by C. Hui.

Ref: Marliave, unpubl.




Figures A–C, Marliave, unpubl.

# *Xiphister atropurpureus* (Kittlitz 1858)

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 75-75-80 | |
| | Precaudal: 22-23-24 | |
| | Caudal: 51-52-56 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | X, 6+7, X | |
| **Pelvic fin** | Absent | |
| **Dorsal fin** | S: 65-X-72 | |
| **Pectoral fin** | R: 11-X-12 | |
| **Anal fin** | S: 1-1-1 | R: 49-X-55 |
| **Gill rakers** | U: 2-X-3 | L: 6-X-10 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Bering Sea, 54-66°N |
| **Ecology** | Nearshore shelf demersal, intertidal to 8 m |
| **ELH pattern** | Oviparous; demersal, adhesive eggs; pelagic larvae |
| **Spawning** | Season: Late winter-early spring (British Columbia)[a]<br>Area: Intertidal, under rocks[a]<br>Progression: Early in protected waters, later on exposed shores[a]<br>Mode: Pairs; males guard nests[b]<br>Migration: |
| **Fecundity** | Range/function: 900-1700[b] |
| **Age at first maturity** | 2-3 yr[c] |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION[d]

### EGGS

| | |
|---|---|
| **Diameter** | 2.25 mm |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | White |
| **Hatch size** | 8.5 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 43-45% SL |
| **Length at flexion** | 11 mm SL |
| **Length at transformation** | 18 mm SL |
| **Sequence of fin development** | Caudal, anal and dorsal, pectorals |

**Pigment**

- Postanal ventral midline with about 36 spots (range 28-46)
- Dorsally about eight spots on gut; ventral pigment present (not shown on figure)
- Row of internal pigment over notochord

**Diagnostic characters**

- See *Anoplarchus purpurescens* (p. 512) and *Phytichthys chirus* (p. 514)

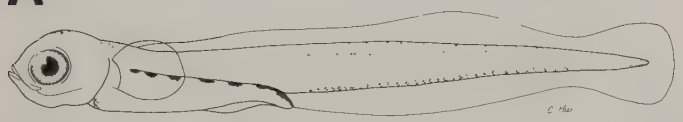
Distinguished from *X. mucosus* by

- Relatively smaller at comparable stages of development
- Internal pigment over notochord generally more prominent
- Relatively short snout-anus length (preanal myomeres 23-25 vs. 28-30 in *X. mucosus*)

[a] Marliave 1975b
[b] Marliave and DeMartini 1977
[c] Wingert 1974
[d] J. Marliave, Vancouver Public Aquarium, P.O. Box 3232, Vancouver, B.C., Canada V6B 3X8, pers. commun., 16 Oct. 1986. Drawings by C. Hui.

Ref: Marliave, unpubl.

A



23–25 preanal myomeres

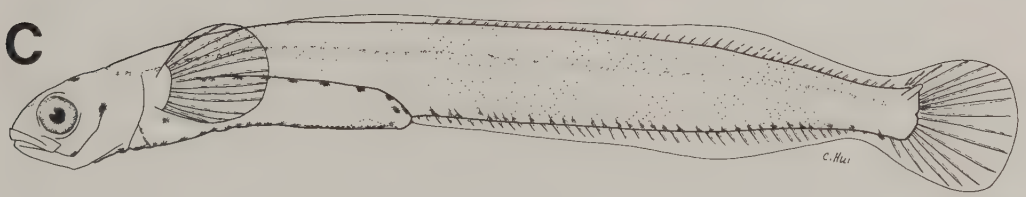
9.5 mm SL

B

Internal pigment prominent

12.5 mm SL

C



18.8 mm SL

Figures A–C, Marliave, unpubl.

# *Xiphister mucosus* (Girard 1858)

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 73-81-83 | |
| | Precaudal: 29-30-31 | |
| | Caudal: 44-50-53 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | X, 6+7, X | |
| **Pelvic fin** | Absent | |
| **Dorsal fin** | S: 71-X-78 | |
| **Pectoral fin** | R: 12-12-12 | |
| **Anal fin** | S: 1-1-1 | R: 46-X-50 |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Cent. California, 34-38°N, to SE Alaska, 55-59°N |
| **Ecology** | Nearshore shelf demersal, intertidal to 18 m |
| **ELH pattern** | Oviparous; demersal, adhesive eggs; pelagic larvae |
| **Spawning** | Season: Late winter-spring (British Columbia)[a] |
| | Area: Exposed intertidal, under rocks[a] |
| | Mode: Pairs; males guard nests[b] |
| | Migration: |
| **Fecundity** | Range/function: 5500-9500[a] |
| **Age at first maturity** | 5 yr[c] |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION[d]

### EGGS

| | |
|---|---|
| **Diameter** | 2.5 mm |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | White |
| **Hatch size** | 9.5 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 47-49% SL |
| **Length at flexion** | 12 mm SL |
| **Length at transformation** | 18 mm SL |
| **Sequence of fin development** | Caudal, dorsal and anal, pectorals |

**Pigment**

- Postanal ventral midline about 26 spots (range 18-35)
- Dorsally about eight spots on gut; ventral pigment present (not shown on figure)
- Row of internal pigment over notochord

**Diagnostic characters**

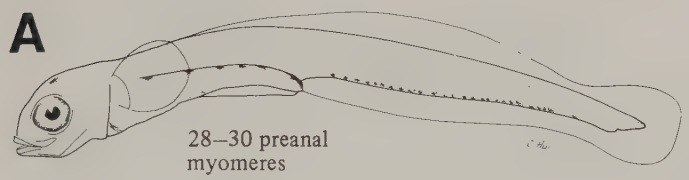
- See *Anoplarchus purpurescens* (p. 512) and *Phytichthys chirus* (p. 514)

Distinguished from *X. atropurpureus* by

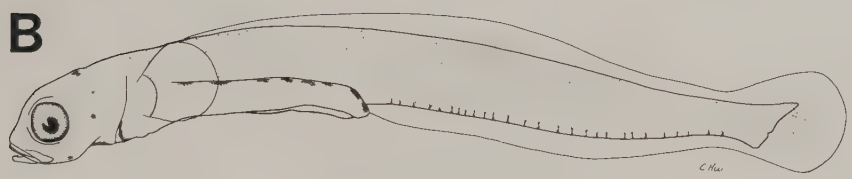
- Generally larger at comparable stages of development
- Internal pigment over notochord generally lighter

[a] Marliave 1975a
[b] Marliave and DeMartini 1977
[c] Wingert 1974
[d] J. Marliave, Vancouver Public Aquarium, P.O. Box 3232, Vancouver, B.C., Canada V6B 3X8, pers. commun., 16 Oct. 1986. Drawings by C. Hui.

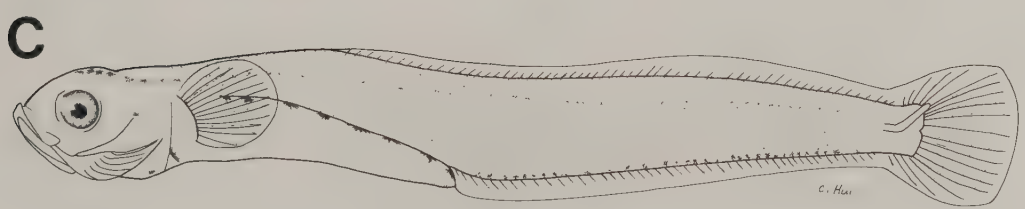
Ref: Marliave 1975a; Marliave, unpubl.




9.5 mm SL




12.7 mm SL




17.3 mm SL

Figures A–C, Marliave, unpubl.

## MERISTICS *Delolepis gigantea* (Kittlitz 1858)

| | | |
|---|---|---|
| **Vertebrae** | Total: 81-X-85 | |
| | Precaudal: X-X-X | |
| | Caudal: 49-X-51 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | X, 7+8, X | |
| **Pelvic fin** | Absent | |
| **Dorsal fin** | S: 73-X-77 | |
| **Pectoral fin** | R: 13-13-13 | |
| **Anal fin** | S: 2-2-2 | R: 43-X-49 |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## MERISTICS *Lyconectes aleutensis* Gilbert 1896

| | | |
|---|---|---|
| **Vertebrae** | Total: 71-X-77 | |
| | Precaudal: X-X-X | |
| | Caudal: 47-X-51 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | X, 7+8, X | |
| **Pelvic fin** | Absent | |
| **Dorsal fin** | S: 60-X-69 | |
| **Pectoral fin** | R: 12-X-13 | |
| **Anal fin** | S: 2-X-3 | R: 45-X-49 |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | N. California, 38-42°N, to Bering Sea, 54-66°N |
| **Ecology** | Nearshore shelf demersal (*D. gigantea*, 6-128 m); epi- and mesobenthal (*L. aleutensis*, 46-350 m) |
| **ELH pattern** | Oviparous, demersal eggs, pelagic larvae |
| **Spawning** | Season: Spring-summer (*L. aleutensis*)[b] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 4.41-4.85 mm (*D. gigantea*); 1.8 mm (*L. aleutensis*) |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | Smooth (*D. gigantea*) |
| **Hatch size** | Larvae with yolk at 16-17 mm SL (*D. gigantea*) |
| **Incubation time/temp.** | |
| **Pigment** | |
| **Diagnostic characters** | |

### LARVAE

| | |
|---|---|
| **Preanal length** | ~50% SL (*D. gigantea*); <50% SL (*L. aleutensis*) |
| **Length at flexion** | |
| **Length at transformation** | |
| **Sequence of fin development** | Caudal, pectorals, dorsal and anal; fin development may begin prior to hatching in *D. gigantea* |
| **Pigment** | |

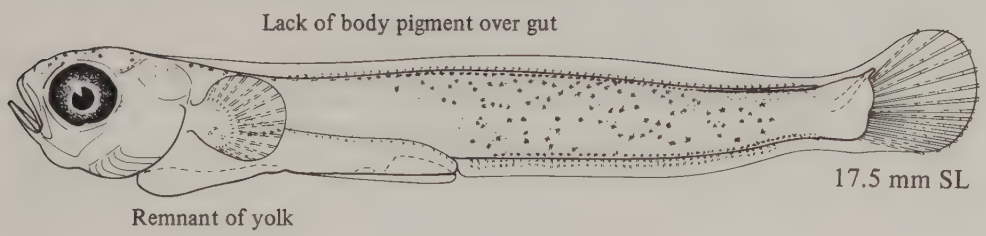
**Diagnostic characters** (see Table 3)

- Number of myomeres: 81-85 in *D. gigantea*, 71-77 in *L. aleutensis*
- Pigment on isthmus and over gut (absent in *D. gigantea*)
- Preanal length: ~50% SL in *D. gigantea*, <50% SL in *L. aleutensis*
- Size at stage of development: *D. gigantea* larvae hatch at a larger size and more advanced stage of development

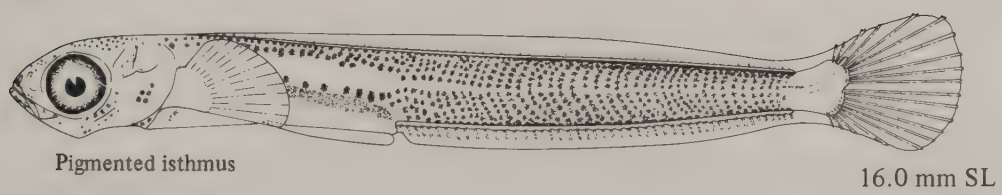
[a] Nawojchik (1986) includes *Lyconectes* and *Delolepis* in the genus *Cryptacanthodes*.
[b] Hart 1973

Ref: Hart 1973.

**A** ***Delolepis gigantea***




**B** ***Lyconectes aleutensis***




Figures A–B, NWAFC originals (B. Vinter).

Although some species of gunnels are found in the North Atlantic, most members of this family are located in the eastern Pacific. Pholidids are eel-like with long compressed bodies, a dorsal fin extending from head to caudal fin and made up entirely of spines, and small pelvic fins (I,1) when present. There are nine species in three genera within the study area.[1] Adults are demersal, occurring from as deep as 75 m to tidepools (Hart 1973). Pholidids are noted for paired spawning and subsequent guarding of eggs which may be 1.4-3.0 mm and have one oil globule (A.C. Matarese, unpubl.). One or both partners may guard the eggs during incubation by coiling around them (Breder and Rosen 1966). Larvae are pelagic and may settle after 50 days (Garrison and Miller 1982).

Presently, larvae of *Pholis* spp. cannot be identified to species in our study area. The following characters may be helpful in separating *Pholis* spp. larvae from those of *Apodichthys flavidus*.

**Morphology** Head and eye generally smaller in *Pholis* at comparable stages of development

**Meristics** Presence of pelvic fins and two anal spines in *Pholis*

**Pigment** Internal pigment above notochord is less pronounced and disappears sometime before larvae undergo flexion; presence of a continuous series of melanophores along ventral surface of gut; pigment spots along dorsal surface of gut are smaller and more numerous (postflexion)

Meristic characters may be useful in separating larger *Pholis* postflexion larvae and juveniles. Off Washington, Oregon, and California, myomere counts enable separation of *P. clemensi* (94-98) and *P. schultzi* (89-93) from other species (usually <90).

Larvae of *Xererpes fucorum* are inadequately known. *X. fucorum* can be separated from *Pholis* spp. by their lack of pelvic fins and from *Apodichthys flavidus* by the presence of one or two anal spines and a lower dorsal spine count (83-87 vs. 90-94).

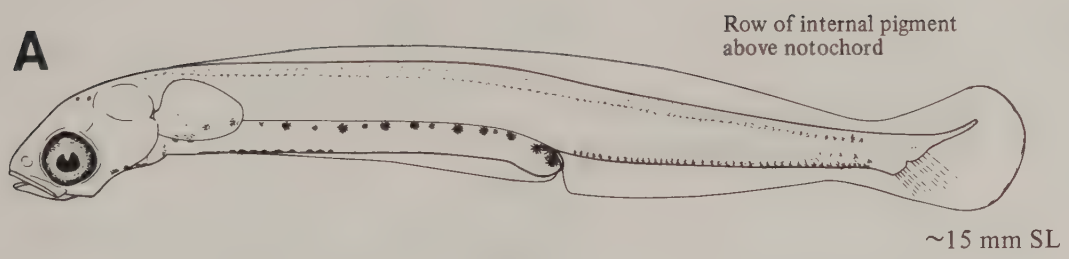
[1]Yatsu (1985) proposes alternative generic placements for several species; according to his arrangement, nine species within four genera occur in the area.

**Table 45**
**Meristic characters of family Pholididae.***

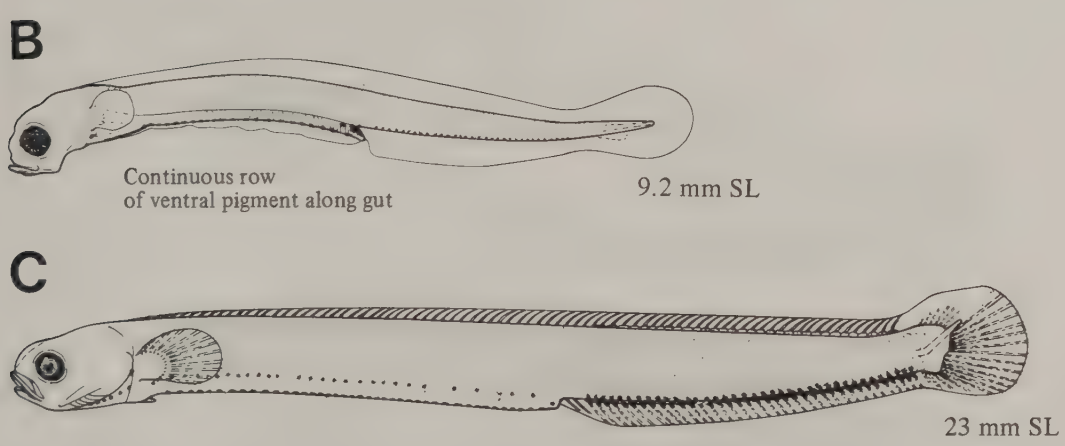
| Taxon | Distribution | Vertebrae | | Fins | | | | Gill rakers | | Branchiostegals |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Precaudal (Total) | Caudal | Dorsal | Anal | Pectoral | Pelvic | Upper | Lower | |
| *Apodichthys flavidus* | S. Calif.-Gulf of Alaska | 50-51 | 48 | XC-XCIV | I,36-42 | 14 | | 3 | 10-13 | 5 |
| *Pholis clemensi* | N. Calif.-SE Alaska | 37-39 | 57-59 | LXXXVII-XCI | II,48-53 | 11-14 | I,1 | | 11 | 5 |
| *Pholis dolichogaster* | Aleutian Is.-Bering Sea | 41-45 | 56-57 | XCIII-XCVI | II,48-51 | 13-15 | I,1 | | | 5 |
| *Pholis fasciata* | Bering Sea | 40-44 | 50 | LXXXIII-LXXXVIII | II,41-44 | 11-13 | I,1 | | | 5 |
| *Pholis gilli* | Bering Sea | | | LXXXIV | II,43 | | I,1 | | | 5 |
| *Pholis laeta* | N. Calif.-Bering Sea | 40-42 (81-89) | 43-44 | LXXIV-LXXXI | II,32-38 | 11-12 | I,1 | | | 5 |
| *Pholis ornata* | Cent. Calif.-Brit. Col. | (80-87) | | LXXIV-LXXX | II,34-38 | 11-12 | I,1 | | | 5 |
| *Pholis schultzi* | Cent. Calif.-Brit. Col. | (89-93) | | LXXX-LXXXIX | II,40-44 | 10-12 | I,1-2 | 1-2 | 7-10 | |
| *Xererpes fucorum* | SSC-Brit. Col. | 52 | 40 | LXXXII-LXXXVII | I,29-38 | 12 | | 1-2 | 6-9 | 5 |

*Yatsu (1985) places *Pholis clemensi*, *P. laeta*, and *P. schultzi* in the genus *Allopholis*. *P. dolichogaster* is placed in the genus *Rhodymenichthys*. *Xererpes fucorum* is placed in the genus *Apodichthys*.

*Apodichthys flavidus*




*Pholis* sp.




Figures A–C, NWAFC originals (B. Vinter).

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 88-X-89 | |
| | Precaudal: 29-X-31 | |
| | Caudal: 57-X-59 | |
| **Branchiostegal rays** | 6-X-7 | |
| **Caudal fin** | | |
| **Pelvic fin** | Absent | |
| **Dorsal fin** | S: 81-X-88 | |
| **Pectoral fin** | R: 20-X-22 | |
| **Anal fin** | S: X-X-X | R: 50-X-55 |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Bering Sea, 54-66°N |
| **Ecology** | Nearshore shelf demersal |
| **ELH pattern** | Oviparous; demersal, adhesive eggs; pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: Pairs; eggs guarded by one or both parents[a] |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 4-8 mm |
| **No. of oil globules** | One |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | ~17-18 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 50% SL |
| **Length at flexion** | <20 mm SL |
| **Length at transformation** | ~40 mm SL |
| **Sequence of fin development** | |

**Pigment** (see Table 3)

- Heavily pigmented over body except ventral surface of gut, pectoral fin base, and posteriormost opercular area

**Diagnostic characters**

Distinguished from *Anarrhichthys ocellatus* by

- Morphology: Body not elongate
- Lower vertebral count (88-89 myomeres)
- Eye diameter (large)

[a] Breder and Rosen 1966

Ref: Andriashev 1954, Barsukov 1959.

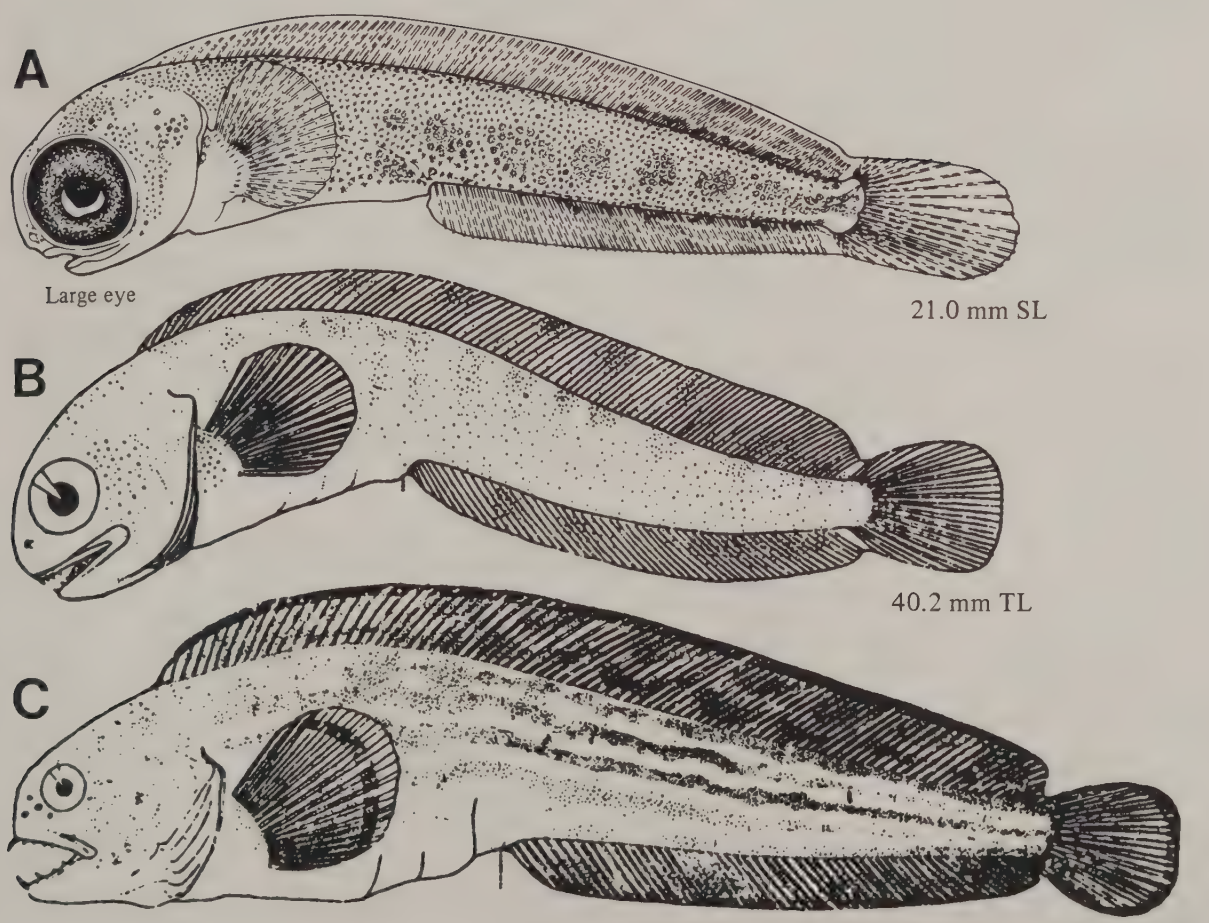



Figure A, NWAFC original (B. Vinter); B–C, Kobayashi 1961a.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 221-247-251 | |
| | Precaudal: 36-37-39 | |
| | Caudal: 183-204-214 | |
| **Branchiostegal rays** | 6-X-7 | |
| **Caudal fin** | | |
| **Pelvic fin** | Absent | |
| **Dorsal fin** | S: 218-X-250 | |
| **Pectoral fin** | R: 19-X-20 | |
| **Anal fin** | S: 0-0-1 | R: 180-X-233 |
| **Gill rakers** | U: 3-X-5 | L: 11-X-15 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Bering Sea, 54-66°N |
| **Ecology** | Epi- and mesobenthal, 0-226 m |
| **ELH pattern** | Oviparous; demersal, adhesive eggs; pelagic larvae |
| **Spawning** | Season: Oct-Feb[a] |
| | Area: In caves or rocky crevices[a] |
| | Mode: Pairs; eggs guarded by both parents[a] |
| | Migration: Mated pairs sedentary, den site permanent[a] |
| **Fecundity** | Range/function: ~10,000[a] |
| **Age at first maturity** | |
| **Longevity** | 4 yr[a] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 5.2-5.4 mm |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | Reddish |
| **Envelope** | Smooth; white, becoming brownish |
| **Hatch size** | 33.5 mm SL |
| **Incubation time/temp.** | 3-4.5 mo |
| **Pigment** | |

**Diagnostic characters**

- Embyro coils around 3-3.5 times within envelope

### LARVAE

| | |
|---|---|
| **Preanal length** | 25% SL at hatching, decreasing with development |
| **Length at flexion** | Tail fully formed at hatching |
| **Length at transformation** | Hatch as juveniles |
| **Sequence of fin development** | Fins fully formed at hatching with yolk present |

**Pigment**

- Dorsal head
- Upper body over gut
- Small concentrated melanophores along dorsal and ventral body midlines that extend onto the body laterally and into the finfolds with development

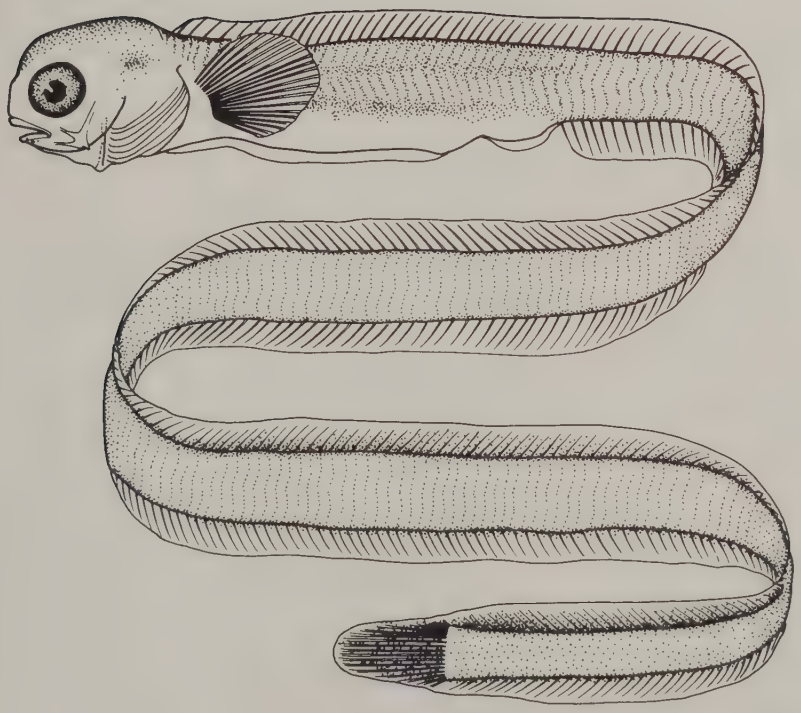
**Diagnostic characters**

- Elongate body shape
- High number of myomeres (221-251)

[a] Marliave 1987

Ref: Marliave 1975a, 1987.

A



65 mm TL

Figure A, Marliave 1975a.

## MERISTICS[a]

| | | |
|---|---|---|
| **Vertebrae** | Total: 227-X-240 | |
| | Precaudal: 53-X-59 | |
| | Caudal: 174-X-181 | |
| **Branchiostegal rays** | 5-5-5 | |
| **Caudal fin** | | |
| **Pelvic fin** | Absent | |
| **Dorsal fin** | S: 83-X-90 | R: 137-X-145 |
| **Pectoral fin** | R: 13-13-13 | |
| **Anal fin** | R: 180-X-196 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Oregon, 42-46°N, to Bering Sea, 54-66°N |
| **Ecology** | Nearshore shelf demersal, 0-80 m |
| **ELH pattern** | Parity and eggs unknown, pelagic larvae |
| **Spawning** | Season: Spring[b] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | Gut length 35-40% SL (decreases with development) |
| **Length at flexion** | |
| **Length at transformation** | ~114 mm SL |
| **Sequence of fin development** | Dorsal and anal first at 40 mm SL |

**Pigment** (larvae 20.3-36.0 mm SL)

- Head
  - —Lower jaw
  - —Isthmus
  - —Internally at base of hindbrain
- Gut: Dorsal and ventral surface
- Body: Concentrated dorsally and ventrally
- Caudal: "Fleshy caudal extension" is distinctly pigmented; pigment is scattered evenly dorsally and ventrally on body and into finfolds

**Diagnostic characters**

- Morphology: Elongate form, gut length (40% SL)
- Number of myomeres (>225)
- Pigment pattern: Concentrated ventrolateral spots and pigment on fleshy caudal extension

[a] Kobayashi (1961b) reports slightly different meristics in specimens from Japanese waters:

| | |
|---|---|
| Dorsal fin spines | 79-83 |
| Dorsal fin rays | 141-157 |
| Anal fin rays | 166-193 |
| Pectoral fin rays | 11-13 |
| Branchiostegal rays | 6 |

Richardson and Dehart (1975) note that in four larval specimens collected off Oregon the total vertebral counts of 227 were considerably lower than counts in Bering Sea specimens (236-240).

[b] Larvae 20.3-36.0 mm SL collected March-May 18 km from coast of Oregon.

Ref: Richardson and Dehart 1975.

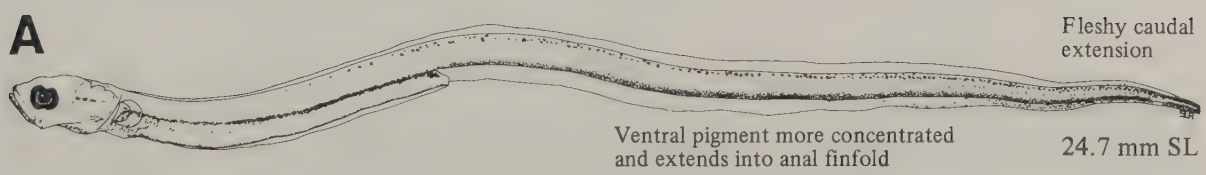



Figure A, Richardson and Dehart 1975.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 61-X-62 | |
| | Precaudal: 24-X-26 | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Absent | |
| **Dorsal fin** | S: 54-X-57 | |
| **Pectoral fin** | R: 20-X-25 | |
| **Anal fin** | S: 4-4-4 | R: 24-X-30 |
| **Gill rakers** | U: 8-8-8 | L: 18-X-20 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Cent. California, 34-38°N, to Bering Sea, 54-66°N |
| **Ecology** | Epi-, meso-, and bathybenthal, 10-675 m |
| **ELH pattern** | Parity and eggs unknown, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | 4 yr (male)[a] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

**Diameter**
**No. of oil globules**
**Oil globule diameter**
**Yolk**
**Envelope**
**Hatch size**
**Incubation time/temp.**
**Pigment**

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 55% SL, with development increasing to 65% SL |
| **Length at flexion** | 17-24 mm BL |
| **Length at transformation** | ~30 mm SL |
| **Sequence of fin development** | Caudal, pectorals, dorsal, anal |

**Pigment**

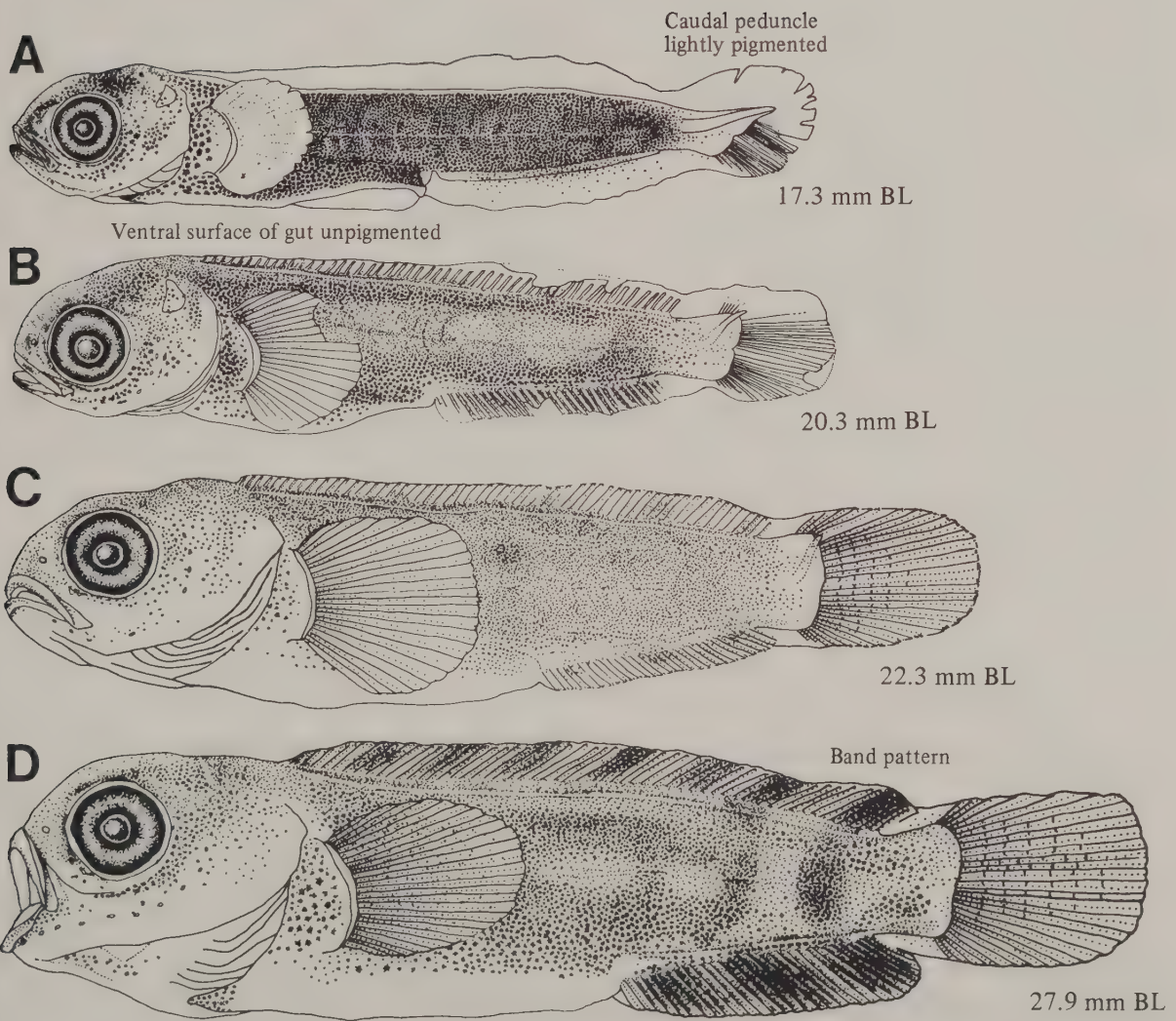
- Body, except ventral surface of gut and tip of tail, entirely pigmented with small densely concentrated melanophores throughout development
- Becomes banded in juveniles

**Diagnostic characters** (see Table 3)

- Small melanophores covering body
- Rounded snout

[a] Fitch and Lavenberg 1971

Ref: Chapman and Townsend 1938, Haryu and Nishiyama 1981.




Figures A–D, Haryu and Nishiyama 1981.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 44-X-47 | |
| | Precaudal: 12-12-14[a] | |
| | Caudal: 32-34-40[a] | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 5-5-5 |
| **Dorsal fin** | S: 14-X-16 | R: 18-X-20 |
| **Pectoral fin** | R: 21-X-22 | |
| **Anal fin** | S: 1-1-1 | R: 28-X-29 |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | N. California, 38-42°N, to Bering Sea, 54-66°N |
| **Ecology** | Epi- and mesobenthal, 20-375 m |
| **ELH pattern** | Oviparous; demersal, adhesive, attached eggs; pelagic larvae |
| **Spawning** | Season: Winter-spring (British Columbia)[a] |
| | Area: Rocky intertidal[a] |
| | Mode: |
| | Migration: Along shore to rocky areas[a] |
| **Fecundity** | Range/function: ~1000[a] |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 3.5 mm |
| **No. of oil globules** | One |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | 13 mm SL (preserved) |
| **Incubation time/temp.** | ~1 yr |
| **Pigment** | |

**Diagnostic characters**

- Precocious caudal development

### LARVAE

| | |
|---|---|
| **Preanal length** | 35-40% SL, increases with development |
| **Length at flexion** | Occurs prior to hatch |
| **Length at transformation** | |
| **Sequence of fin development** | Caudal, dorsal and anal, pectorals and pelvics |

**Pigment**

- On about every other myomere along ventral midline
- Distinct spots on hypural margin, increase in number with development to become a line
- Large melanophores cover entire surface of gut
- Several large melanophores on crown
- Anterior dorsal midline starts on nape, increases posteriorly

**Diagnostic characters**

- Early caudal development
- Hypural margin pigment: First forms line, then an anteriorly open bracket; similar smaller bracket develops on the caudal peduncle
- Slightly separate dorsal fins
- Anal fin longer than second dorsal fin

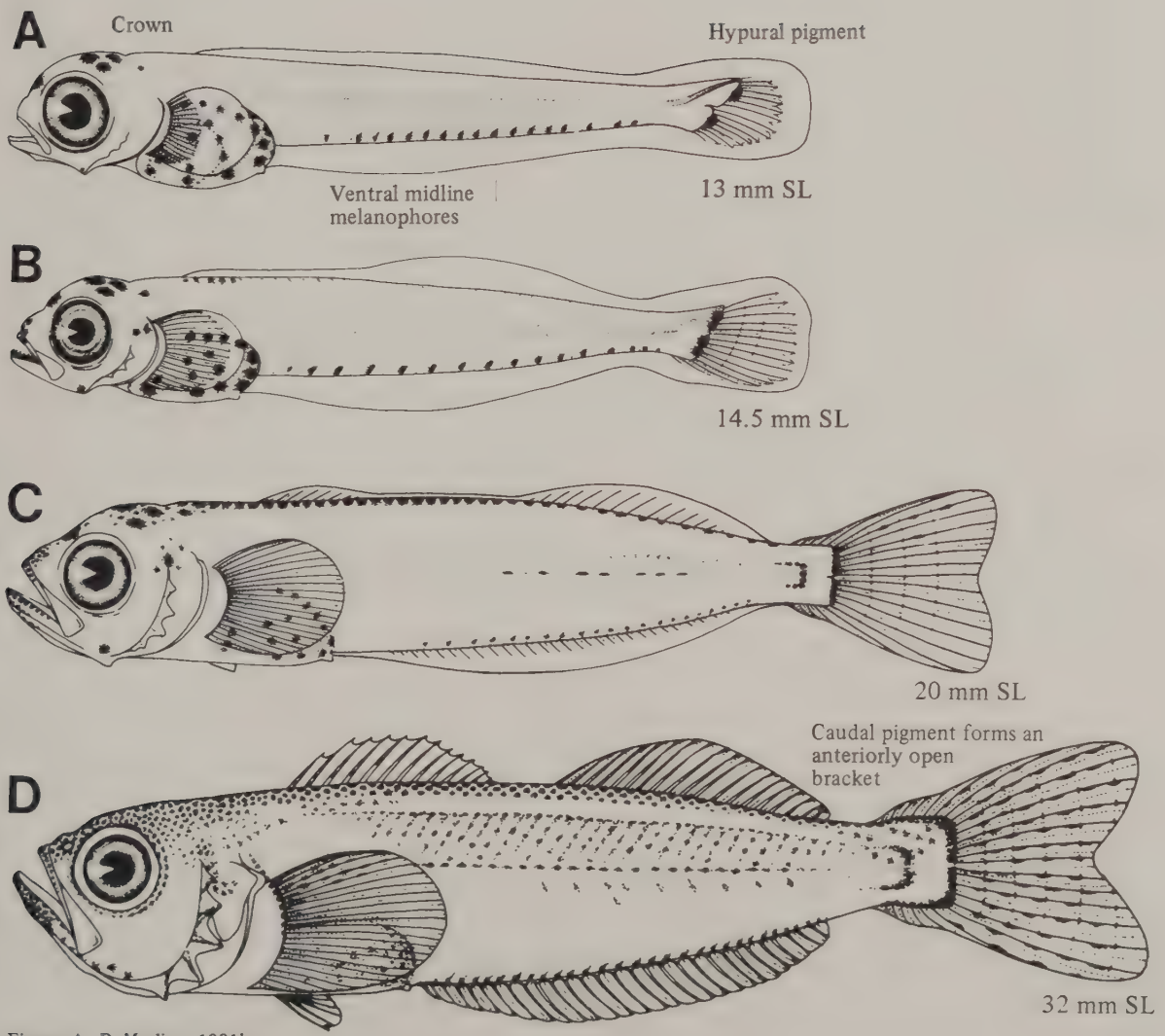
To distinguish from *Arctoscopus japonicus* (present in the Bering Sea)[b]

- *A. japonicus* larvae are less advanced at similar stages of development than those of *T. trichodon*, e.g., newly hatched *A. japonicus* larvae possess no developing fin rays and an unflexed notochord
- Dorsal margin pigment not present until juvenile stage in *A. japonicus*
- *A. japonicus*: Dorsal X-XI,13; anal 30-31

[a] Marliave 1981c

[b] M. Okiyama, Univ. Tokyo, Ocean Res. Inst., 1-15-1 Minamidai, Nakano-Ku, Tokyo 164, Japan, pers. commun., 8 Nov. 1985.

Ref: Marliave 1981c.




Figures A–D, Marliave 1981b.

Clinids are found in both Atlantic and Pacific tropical and temperate waters. They are small (many <7.5 cm) and elongate, and somewhat deep-bodied. The dorsal fin extends from behind the head almost to the caudal fin. In the northeastern Pacific the family is represented by only three species in two genera. Adults inhabit nearshore rocky areas from intertidal zones to depths of 50 m. Spawning behavior consists of nest building by a male in a rocky crevice, on seaweed, or in the lumen of a living sponge (Breder and Rosen 1966). Eggs, which are laid by one or more females, form clumps. The adhesive eggs (0.85-1.7 mm) have one or more oil globules which may be uncolored, pale yellow, or orange; sticky filaments are present on eggs of some species. Males of some tribes possess a modified anal fin or intromittent organ (Ophiclini, Clinini), and reproduction within those tribes is either viviparous or ovoviviparous. Larvae are pelagic for a brief period before settling to the bottom (Breder and Rosen 1966). The early-life-history stages of *Heterostichus rostratus* are presented here. Other clinids in the study area include two species of the genus *Gibbonsia*. In comparison to *H. rostratus*, members of *Gibbonsia* have fewer myomeres (48-54), anal fin rays (23-29), pectoral fin rays (11-13), and upper gill rakers (3-4). They undergo flexion and transformation earlier than *H. rostratus* (5.0-8.1 mm SL and ~19 mm SL, respectively).[1] Pigment is generally limited to the ventral midline and dorsally over the swimbladder.

[1]W. Watson, Marine Ecological Consultants, 531 Encinitas Blvd., Suite 110, Encinitas, CA 92024, pers. commun., 1983.

**Table 46**
**Meristic characters of family Clinidae.**

| | | Vertebrae | | Fins | | | | Gill rakers | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Taxon | Distribution | Precaudal | Caudal | Dorsal | Anal | Pectoral | Pelvic | Upper | Lower | Branchiostegals |
| *Gibbonsia metzi* | SSC-Brit. Col. | 18-20 | 32-34 | XXXIV-XXXVII, 7-10 | II,24-29 | 11-13 | I,3 | 3-4 | 7-8 | 5-6 |
| *Gibbonsia montereyensis* | SSC-Brit. Col. | 16-17 | 32-35 | XXXIV-XXXVI, 5-8 | II,23-28 | 11-13 | I,3 | 3-4 | 7-12 | 6 |
| *Heterostichus rostratus* | SSC-Brit. Col. | 21-22 | 34-36 | XXXV-XXXVIII, 11-13 | II,31-35 | 12-14 | I,3 | 5-7 | 12-13 | 6 |

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 55-57-58 | |
| | Precaudal: 21-22-22 | |
| | Caudal: 34-35-36 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 3-3-3 |
| **Dorsal fin** | S: 35-37-38 | R: 11-X-13 |
| **Pectoral fin** | R: 12-13-14 | |
| **Anal fin** | S: 2-2-2 | R: 31-X-35 |
| **Gill rakers** | U: 5-X-7 | L: 12-X-13 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Brit. Col., 48°30′-55°N |
| **Ecology** | Nearshore shelf demersal, intertidal to 40 m |
| **ELH pattern** | Oviparous; adhesive, attached eggs; pelagic[a] larvae |
| **Spawning** | Season: Mar;[b] Feb-Apr;[c] spring[a]<br>Area: Egg mass found on floating kelp filaments[a]<br>Mode: Pairs; males guard nests[a]<br>Migration: |
| **Fecundity** | Range/function: 400-1200 (may spawn several times/yr)[a] |
| **Age at first maturity** | 1-1.5 yr[a] (females 14 cm TL) |
| **Longevity** | 5 yr (females)[a]<br>3 yr (males)[a] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.35 mm;[d] 1.4 mm[a] |
| **No. of oil globules** | One |
| **Oil globule diameter** | |
| **Yolk** | Red or brown |
| **Envelope** | 16 filaments in a cluster |
| **Hatch size** | 5.5-6.2 mm TL |
| **Incubation time/temp.** | 12-17 d/18°C |

**Pigment**

- Yolk
- Ventral midline melanophores on embryo

**Diagnostic characters**

- Filaments

### LARVAE

| | |
|---|---|
| **Preanal length** | 50% SL |
| **Length at flexion** | ~7-9 mm SL |
| **Length at transformation** | By 25 mm SL, 30-50 mm TL |
| **Sequence of fin development** | Caudal, dorsal and anal, pectorals and pelvics |

**Pigment**

- Postanal ventral midline series: Denser posteriorly, with development becoming about one melanophore at base of each anal fin ray
- Anteriorly and dorsally on gut

**Diagnostic characters**

- Pigmented swimbladder (not shown on figures)
- Ventral midline melanophores
- More myomeres (56-60) than *Gibbonsia* spp. (47-53)
- Dorsal and anal fin development begins posteriorly

[a] Stepien 1986
[b] Wang 1981
[c] W. Watson, Marine Ecological Consultants, 531 Encinitas Blvd., Suite 110, Encinitas, CA 92024, pers. commun., 3 Nov. 1986.
[d] Barnhart 1932

Ref: Barnhart 1932, Matarese et al. 1984a, Stepien 1986.

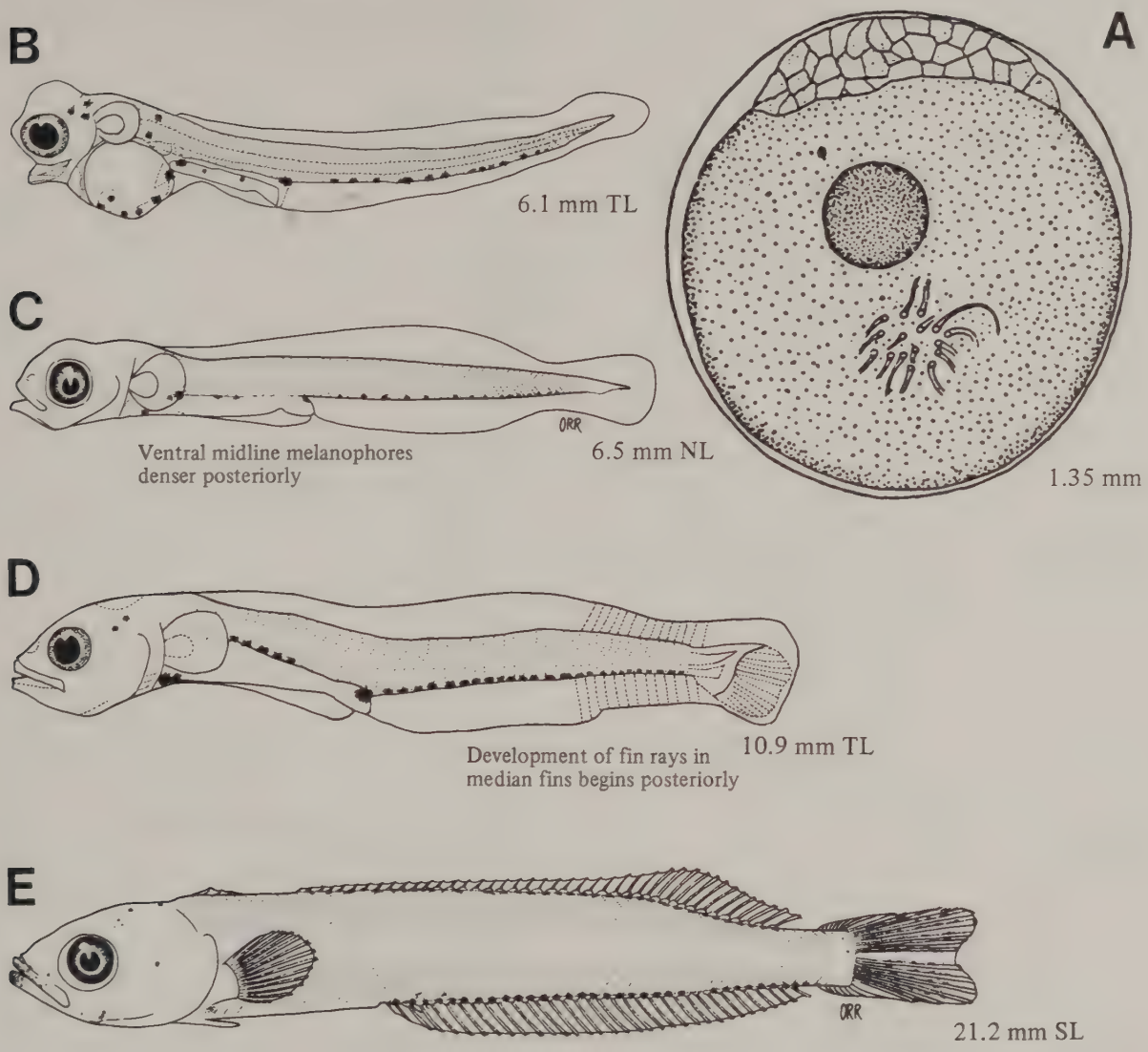



Figure A, Barnhart 1932; B, D, Stepien 1986 (reared); C, E, Matarese et al. 1984a.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 66-X-68 |
| | Precaudal: 23-23-23 |
| | Caudal: 45-45-45 |
| **Branchiostegal rays** | 6-X-7 |
| **Caudal fin** | 6-9, 9+8, 6-9 |
| **Pelvic fin** | Abdominal in larvae, absent in adults |
| | S: 1-1-1 R: 4-4-4 |
| **Dorsal fin** | R: 52-X-56 |
| **Pectoral fin** | R: 20-X-21 |
| **Anal fin** | R: 34-X-44 |
| **Gill rakers** | U: 1-1-1 L: 6-6-6 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Bering Sea, 54-66°N |
| **Ecology** | Epi- and mesopelagic |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Spring-early summer, early fall;[a] winter[b] |
| | Area: Pelagic[a] |
| | Mode: |
| | Migration: To coastal areas[b] |
| **Fecundity** | Range/function: 230,000-430,000[b] |
| **Age at first maturity** | 3-4 yr[b] |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 2.8-3.1 mm |
| **No. of oil globules** | One |
| **Oil globule diameter** | Initially 0.42-0.60 mm |
| **Yolk** | Homogeneous, opaque becoming clear |
| **Envelope** | Smooth |
| **Hatch size** | 6.5 mm SL |
| **Incubation time/temp.** | |

**Pigment**

- Yolk
- Oil globule
- Embryo: Finfolds, above and below tail, body

**Diagnostic characters**

- Large size
- Large oil globule, decreasing in size with embryonic development

### LARVAE

| | |
|---|---|
| **Preanal length** | ~40% SL |
| **Length at flexion** | 11-17 mm SL |
| **Length at transformation** | |
| **Sequence of fin development** | Pectorals, pelvics, dorsal, anal; caudal not complete in 28.5 SL specimen |

**Pigment**

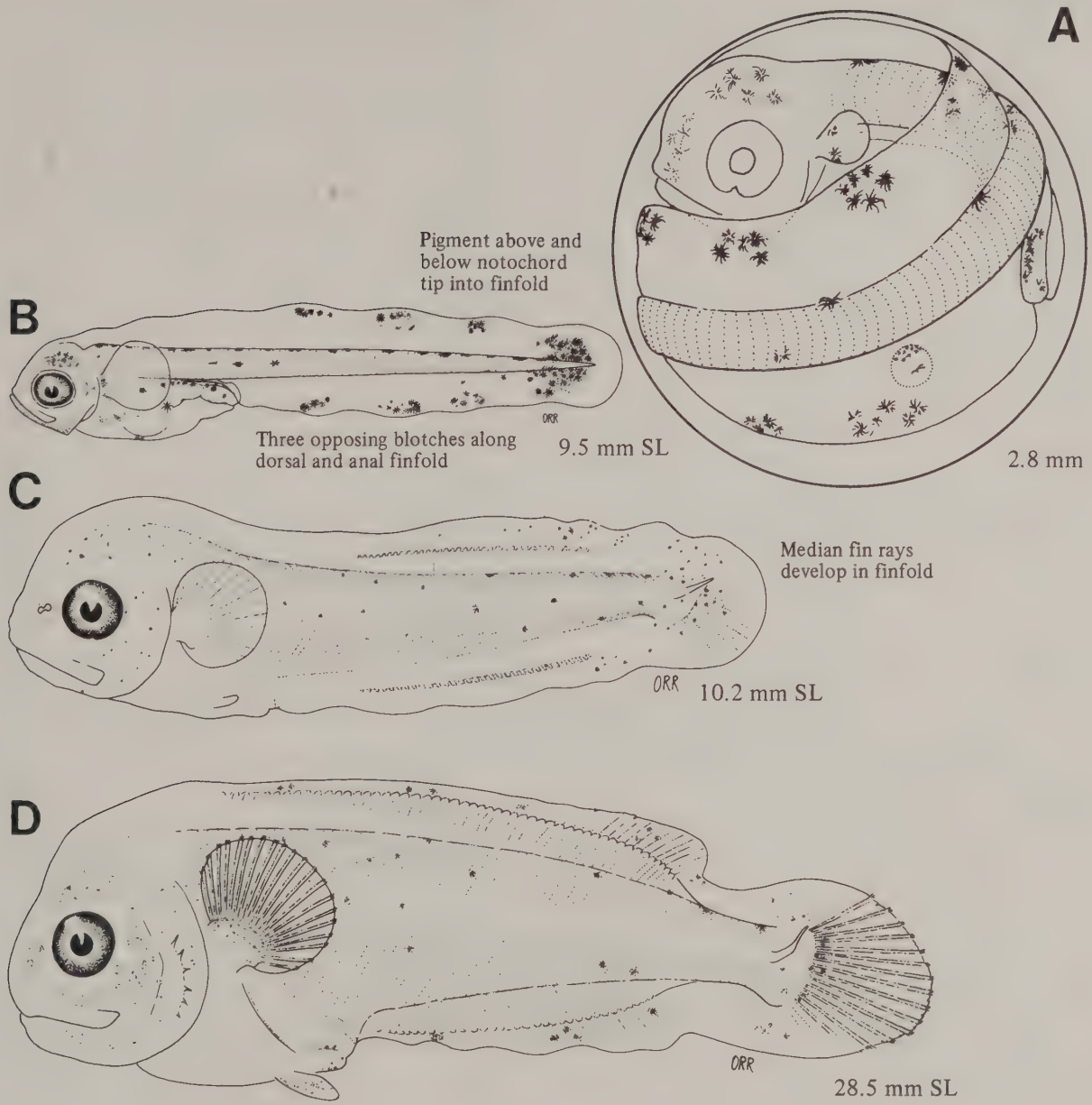
- Head and gut covered with discrete spots
- Dorsal body margin
- Caudal finfold pigment becoming less prominent with development
- Pectoral and pelvic fin bases (postflexion)
- Three opposing blotches on dorsal and ventral finfolds in preflexion larvae

**Diagnostic characters**

- Preflexion pigment: Three opposing blotches in median finfold, one in caudal finfold
- Pelvic fin present in larvae, lost in adults
- Dorsal and anal fin begin to develop in finfold, have deep bases
- Morphological changes with development, from elongate to deep-bodied
- Blunt head
- Small preopercular spines

[a] NWAFC, unpubl.
[b] Fitch and Lavenberg 1971

Ref: Matarese et al. 1984b; Matarese, unpubl.




Figures A–D, Matarese et al. 1984b.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 65-67-74<br>Precaudal: 40-44-47<br>Caudal: 23-24-25 |
| **Branchiostegal rays** | 6-X-8 |
| **Caudal fin** | X, 8+7, X |
| **Pelvic fin** | Absent |
| **Dorsal fin** | R: 54-X-63 |
| **Pectoral fin** | R: 13-14-15 |
| **Anal fin** | R: 24-X-32 |
| **Gill rakers** | U: 3-X-6 L: 16-X-22 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Arctic, not specific |
| **Ecology** | Epi- and mesobenthal, intertidal to 275 m |
| **ELH pattern** | Oviparous; demersal, adhesive eggs; pelagic larvae |
| **Spawning** | Season: Nov-Feb[a]<br>Areas: In areas of strong current[b]<br>Mode:<br>Migration: |
| **Fecundity** | Range/function: 1000[c] (*A. personatus*, western Pacific)-22,100[d] (southwestern Barents Sea) |
| **Age at first maturity** | 1 yr[e] (western Pacific) |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 0.67-0.91 mm (0.80 mm) |
| **No. of oil globules** | One |
| **Oil globule diameter** | ~0.26 mm |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | 6-7 mm SL (as small as 4 mm) |
| **Incubation time/temp.** | 2-12 wk |

**Pigment**

- Embryo: Eyes, dorsal and ventral body

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | ~60% SL |
| **Length at flexion** | 11-13 mm SL |
| **Length at transformation** | 16-31 mm SL |
| **Sequence of fin development** | Caudal, pectorals, dorsal and anal |

**Pigment**

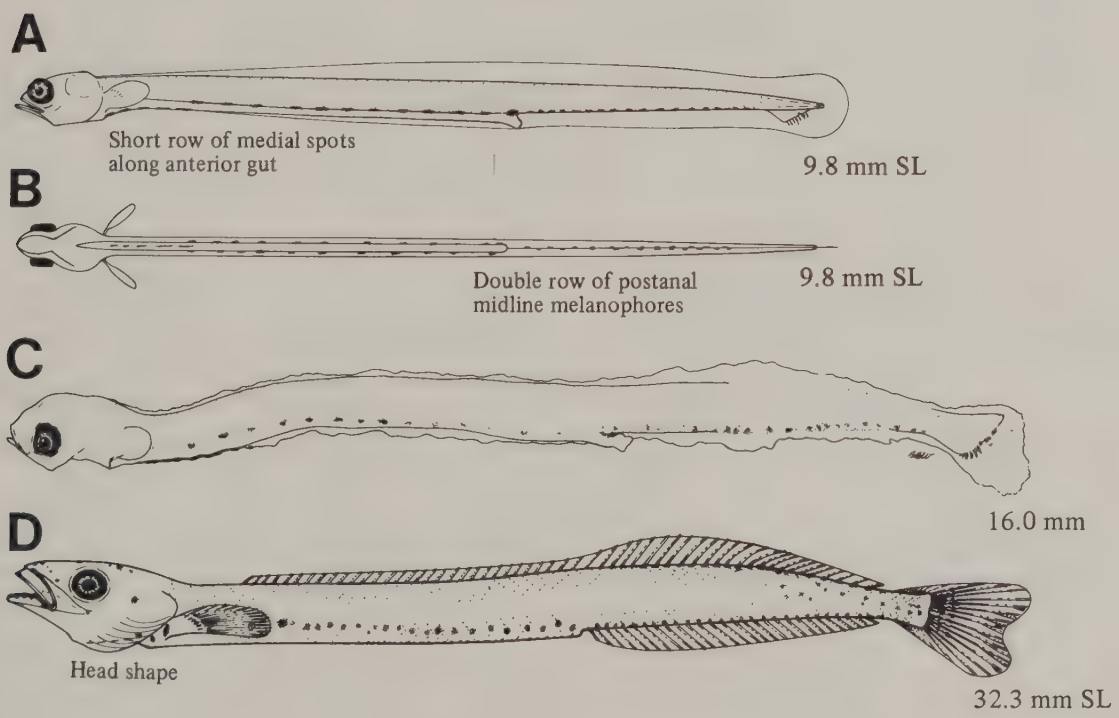
- Gut
- Double row postanal ventral pigment

**Diagnostic characters** (see Table 4)

- Elongate body
- Gut length (~60% SL)
- Lightly pigmented
- Postanal ventral pigment (double row)
- Dorsal and anal fins begin development opposed to each other
- Elongate head shape in larger specimens

[a] Trumble 1973
[b] Andriashev 1954
[c] Inoue et al. 1967
[d] Macy et al. 1978
[e] Hamada 1966

Ref: Kobayashi 1961c, Stevens et al. 1984.




Figures A–B, D, (B, ventral view), NWAFC originals (B. Vinter); C, Stevens et al. 1984.

Gobiidae is the most speciose family of marine fishes, although some species occur in brackish or freshwater environments. Gobies are generally small bottom-dwelling fishes with pelvic fins united to form a sucking disc. Found mainly in subtropical and tropical areas, adults inhabit shallow to moderate depths in salt and brackish water (some in freshwater). The study area includes three species: *Clevelandia ios*, *Coryphopterus nicholsi*, and *Lepidogobius lepidus*. Larvae are easily recognized by their conspicuously pigmented swimbladder and pigment patterns. Larvae are commonly collected inshore and in bays and estuaries. They are rare in coastal ichthyoplankton collections in the study area.

Small larvae of *Clevelandia* and *Lepidogobius* have been confused for some time in the literature. Since we have incomplete developmental series of the two species, we are presenting a consensus of opinion from researchers who have had more experience studying or collecting gobies. Gobiid larvae with three dorsal melanophores previously assigned to *Clevelandia* are now considered *Lepidogobius* (Wang 1986; W. Watson and G. McGowen, pers. commun.[1]).

[1]W. Watson, Marine Ecological Consultants, 531 Encinitas Blvd., Suite 110, Encinitas, CA 92024, pers. commun., 3 Nov. 1986; G. McGowen, Los Ang. Cty. Mus. Nat. Hist., 900 Exposition Blvd., Los Angeles, CA 90036, pers. commun., 31 Oct. 1986.

**Table 47**
**Early-life-history characters of gobiid larvae from the Northeast Pacific (Wang 1981, in part).**

| | *Clevelandia ios* | *Coryphopterus nicholsi* | *Lepidogobius lepidus* |
|---|---|---|---|
| **Spawning Site** | Burrow | Rocky reef | Burrow |
| **Egg Shape** | Elliptical with narrow, blunt distal end | Spindle-shaped, narrow, elongate | Elliptical |
| **Larvae** | | | |
| Total myomeres | 34-36 | 25-26 | 36-38 |
| Preanal myomeres | 16-18 | 9-10 | 14-17 |
| Postanal myomeres | 16-19 | 14-17 | 19-23 |
| Distinguishing pigmentation | Single large melanophore along dorsal midline of body which forms a band at about myomere 26 | A series of 10-15 melanophores along ventral body midline and a shorter series along dorsal midline near caudal | Three dorsal midline melanophores, posteriormost forming a band at about myomeres 19-26 |
| **Juveniles** | | | |
| Dorsal fin | IV-VI; 0-I, 14-17 | V-VI; I-II, 9-15 | VI-IX; 0-I, 14-18 |
| Anal fin | 0-I, 14-17 | 0-I, 11-14 | 0-I, 13-16 |
| Pectoral fin | 18-21 | 21-24 | 20-22 |
| Vertebrae | 35-37 | 26 | 37-38 |
| Distribution | Seawater-polyhaline-oligohaline | Seawater-polyhaline | Seawater-polyhaline-oligohaline |
| Distinguishing characteristics | ~12 dark bands on dorsum; ~12 close melanophores on lateral line | Large black eye; black margin on spinous dorsal fin; side of body without dark vertical bands | Black margin on spinous dorsal fin; broad dark band at base of caudal region; body pigmentation light |

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 35-36-37 | |
| | Precaudal: 15-15-15 | |
| | Caudal: 21-21-22 | |
| **Branchiostegal rays** | 3-X-5 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | R: 5-5-5 | |
| **Dorsal fin** | 1st S: 4-X-6 | |
| | 2nd S: 0-X-1 | R: 14-X-17 |
| **Pectoral fin** | R: 20-20-20 | |
| **Anal fin** | S: 0-X-1 | R: 14-X-17 |
| **Gill rakers** | U: 1-X-3 | L: 5-X-7 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Brit. Col., 48°30′-55°N |
| **Ecology** | Intertidal |
| **ELH pattern** | Oviparous; demersal, attached eggs; pelagic larvae |
| **Spawning** | Season: Nov-June or later[a]<br>Area:<br>Mode:<br>Migration: |
| **Fecundity** | Range/function: 750-1000 (may be multiple spawners)[b]/ $F=0.0306\times L^{2.04}$ [c] |
| **Age at first maturity** | 1 yr[c] |
| **Longevity** | 2-3 yr[c] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 0.70-0.85 mm |
| **No. of oil globules** | Many coalescing to one |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | Transparent; adhesive threads at one pole |
| **Hatch size** | 2.7-3.8 mm SL |
| **Incubation time/temp.** | 10-12 d/15-15.5°C |
| **Pigment** | |

**Diagnostic characters**
- Ellipsoidal

### LARVAE

| | |
|---|---|
| **Preanal length** | 45-52% SL |
| **Length at flexion** | |
| **Length at transformation** | |
| **Sequence of fin development** | Caudal, 2nd dorsal and anal, 1st dorsal and pectorals, pelvics |

**Pigment**
- Single large melanophore along dorsal midline of body which forms a band at about myomere 26
- Dorsal surface of swimbladder

**Diagnostic characters** (see Table 47)
- Conspicuously pigmented swimbladder (family)

Distinguished from *Coryphopterus nicholsi* by
- Total myomeres (fewer in *C. nicholsi*, 25-26 vs. 35-37)

Distinguished from *Lepidogobius lepidus* by
- Pigment pattern: No anterior melanophores along dorsal midline; present in *L. lepidus*

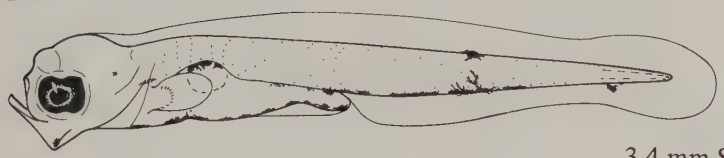
**Postflexion**
- Dorsal spine count (4-6), anal count (14-17), mouth size

[a] Wang 1981
[b] Prasad 1958
[c] Brothers 1975

Ref: Prasad 1958, Ruple 1984, Wang 1981.

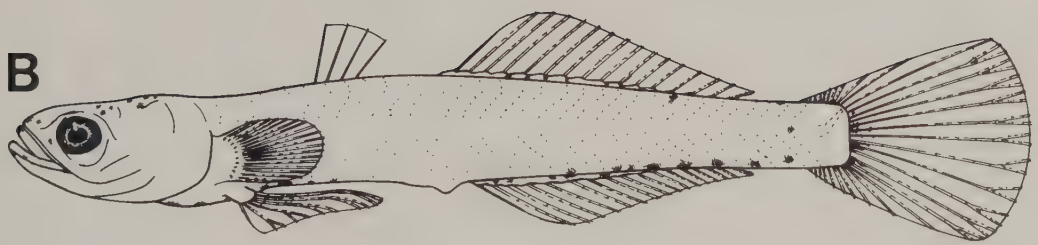
A

One blotch along dorsal surface posteriorly



3.4 mm SL

B



15.0 mm SL

Figures A–B, NWAFC originals (B. Vinter; specimens loaned by Bruce Mundy, formerly of Oregon State University. The 15.0 mm SL specimen was slightly damaged, so the swimbladder could not be accurately illustrated).

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 26-26-26 | |
| | Precaudal: 11-11-11 | |
| | Caudal: 15-15-15 | |
| **Branchiostegal rays** | 3-X-5 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | R: 6-6-6 | |
| **Dorsal fin** | 1st S: 4-X-8 | |
| | 2nd S: 1-X-2 | R: 9-X-15 |
| **Pectoral fin** | R: 16-X-23 | |
| **Anal fin** | S: 0-X-1 | R: 11-X-13 |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Brit. Col., 48°30′-55°N |
| **Ecology** | Nearshore shelf demersal, intertidal to 106 m |
| **ELH pattern** | Oviparous; demersal, attached eggs; pelagic larvae |
| **Spawning** | Season: Feb[a]-Oct[b] (California)<br>Area: Under rocks[a]<br>Mode: Pairs; eggs guarded by males[a]<br>Migration: |
| **Fecundity** | Range/function: 3274-4788 (may be multiple spawners)[a] |
| **Age at first maturity** | 2-5 yr (females)[a]<br>3-5 yr (males)[a] |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 2.1×0.48 mm |
| **No. of oil globules** | Multiple |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | Transparent, smooth |
| **Hatch size** | 2.94 mm TL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

- Ellipsoidal (pointed at each end)
- Pigmented dorsally over yolk and along ventral body midline

### LARVAE

| | |
|---|---|
| **Preanal length** | 50% SL |
| **Length at flexion** | |
| **Length at transformation** | |
| **Sequence of fin development** | Caudal, 2nd dorsal and anal, 1st dorsal and pectorals, pelvics |

**Pigment**

- Dorsal surface of swimbladder
- Dorsal surface of posterior gut
- Series of dorsal midline melanophores along posterior half of body
- 10-15 postanal ventral melanophores
- With development, pigment in hypural area

**Diagnostic characters** (see Table 47 and *Clevelandia ios*, p. 544)

- Myomeres (26)

[a] Wiley 1973
[b] Ebert and Turner 1962

Ref: Ruple 1984, Wang 1981.

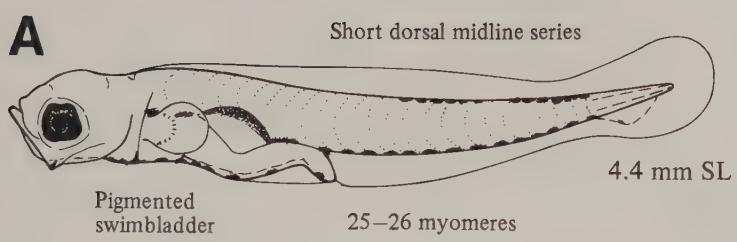



Figure A, NWAFC original (B. Vinter; specimen loaned by Bruce Frost, University of Washington, for illustration).

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 37-37-38 | |
| | Precaudal: 15-15-15 | |
| | Caudal: 22-22-23 | |
| **Branchiostegal rays** | 3-X-4 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | R: 5-5-5 | |
| **Dorsal fin** | 1st S: 6-X-9 | |
| | 2nd S: 0-X-1 | R: 14-X-18 |
| **Pectoral fin** | R: 20-20-20 | |
| **Anal fin** | S: 0-X-1 | R: 13-X-16 |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Brit. Col., 48°30′-55°N |
| **Ecology** | Nearshore shelf demersal, intertidal to 201 m |
| **ELH pattern** | Oviparous, demersal eggs, pelagic larvae |
| **Spawning** | Season: Nov-June (California)[a]<br>Area: Intertidal mudflats[a]<br>Mode:<br>Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.3-1.8 × 0.8-1.0 mm (unfertilized) |
| **No. of oil globules** | Many (unfertilized) |
| **Oil globule diameter** | |
| **Yolk** | Granular, yellowish |
| **Envelope** | Transparent, smooth |
| **Hatch size** | |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 42-45% TL |
| **Length at flexion** | |
| **Length at transformation** | |
| **Sequence of fin development** | Caudal, 2nd dorsal and anal, 1st dorsal and pectorals, pelvics |

**Pigment**

- Dorsal surface of swimbladder
- Three dorsal midline melanophores, posteriormost forming a band at about myomeres 19-26

**Diagnostic characters** (see Table 47 and *Clevelandia ios*, (p. 544)

Distinguished from *C. ios* by

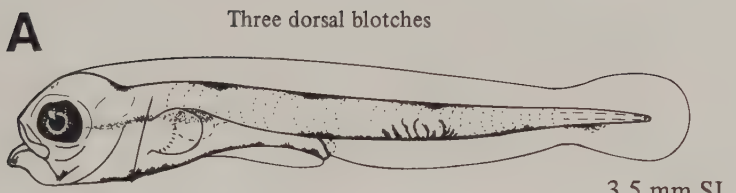
- Anterior melanophores along dorsal midline; not present in *C. ios*

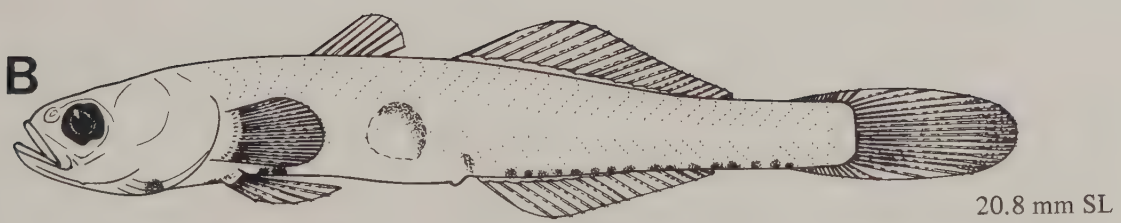
Distinguished from *Coryphopterus nicholsi* by

- Total myomeres (fewer in *C. nicholsi*, 25-26 vs. 37-38)

[a] Wang 1981

Ref: Ruple 1984, Wang 1981.




Figures A–B, NWAFC originals (B. Vinter; specimens loaned by Bruce Mundy, formerly of Oregon State University, for illustration).

There are four species of cutlassfishes in three genera of this family in the northeastern Pacific. General body shape is elongate and ribbonlike, tapering to a small caudal fin. Voracious predators, most have a large, well-toothed mouth and pointed snout. Adult cutlassfishes are benthopelagic but have been found at the surface at night (Fritzsche 1978). Spawning occurs offshore, resulting in pelagic eggs which can be 1.6-2.5 mm and have a single reddish-yellow oil globule (Breder and Rosen 1966, Fritzsche 1978). Pelagic larvae have a high myomere count (generally >100) and develop three dorsal spines, the first of which may be elongate (Schmidt and Strubberg 1918). Larvae have a small head with a long, tapering body (Ozawa 1986e). No early-life-history stages have been collected in our area.

**Table 48**
**Meristic characters of family Trichiuridae.**

| Taxon | Distribution | Vertebrae | | Fins | | | | Gill rakers | | Branchiostegals |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Precaudal (Total) | Caudal | Dorsal | Anal | Pectoral | Pelvic | Upper | Lower | |
| *Aphanopus carbo* | N. Calif.-Brit. Col. | 42-46 | 55-59 | XXXVIII-XLIII, 53-56 | I-II, 44-49 | 12 | I,1 | | | 7-8 |
| *Benthodesmus elongatus* | Cent. Calif.-Brit. Col. | (148-153) | | XLIV-XLVII, 98-102 | II, 91-98 | 12 | I,1 | 5 | 9 | 7 |
| *Benthodesmus tenuis* | Brit. Col. | (121-131) | | XXXIX-XLII, 79-88 | II, 69-75 | | | | | |
| *Lepidopus fitchi* | SSC-Oregon | 35 (84-92) | 50 | IX, 78-86 | II, 41-49 | 12 | I,1* | 7 | 10 | 7 |

*The soft ray is rudimentary (Rosenblatt and Wilson 1987).

## MERISTICS — *B. elongatus* (Steindachner 1891)

| | | |
|---|---|---|
| **Vertebrae** | Total: 148-X-153 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 7-7-7 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 1-1-1 |
| **Dorsal fin** | S: 44-44-47 | R: 98-X-102 |
| **Pectoral fin** | R: 12-12-12 | |
| **Anal fin** | S: 2-2-2 | R: 91-93-98 |
| **Gill rakers** | U: 5-5-5 | L: 9-9-9 |

## MERISTICS — *B. tenuis* (Günther)

| | | |
|---|---|---|
| **Vertebrae** | Total: 121-X-131 | |
| | Precaudal: X-X-X | |
| | Caudal: X-X-X | |
| **Branchiostegal rays** | 7-7-7 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | S: X-X-X | R: X-X-X |
| **Dorsal fin** | S: 39-X-42 | R: 79-X-88 |
| **Pectoral fin** | R: X-X-X | |
| **Anal fin** | S: 2-2-2 | R: 69-X-75 |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Cent. California, 34-38°N,[a] to Brit. Col., 48°30′-55°N |
| **Ecology** | Epi- and mesopelagic |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

[a] *B. tenuis* range restricted to British Columbia.

[b] Description based on *B. elongatus simonyi*, a subspecies from the North Atlantic, and *B. elongatus pacificus* from Japan. Ozawa (1986e) describes and figures one late postflexion larva of *B. tenuis* (27.1 mm SL). Larvae of *B. elongatus* and *B. tenuis* from our area may differ.

[c] Ozawa 1986e

Ref: Collette et al. 1984b, Evseenko 1982, Gorbunova 1982b, Ozawa 1986e, Peden and Hughes 1986.

## EARLY LIFE HISTORY DESCRIPTION

### EGGS - Family

| | |
|---|---|
| **Diameter** | 1.7-2.0 mm |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | 4.5-6.5 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE[b]

| | |
|---|---|
| **Preanal length** | |
| **Length at flexion** | |
| **Length at transformation** | |
| **Sequence of fin development** | Dorsal first fin to develop |

**Pigment**

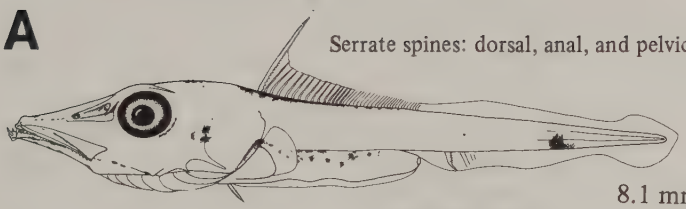
- Blotch on upper preopercle
- Crown
- Dorsal midline beginning just anterior to dorsal fin origin and running along developing fin, increasing with development
- Dorsolateral gut
- Ventrolateral blotch about mid-postanal body; with development becoming a series along ventral midline about 3/4 length of anal fin
- *B. elongatus pacificus* has a blotch at the origin of the anal fin (not shown on figure)[c]

**Diagnostic characters**

- Family
  - —Serrate spines in dorsal, anal, and pelvic fins
  - —In some genera (e.g., *Benthodesmus*), the anterior-most rays of the dorsal fin are extremely elongate in the smallest larvae
- Genus
  - —Caudal fin development distinct
  - —Pelvic fin located approximately below pectoral fin
  - —Number of dorsal fin spines (>30)

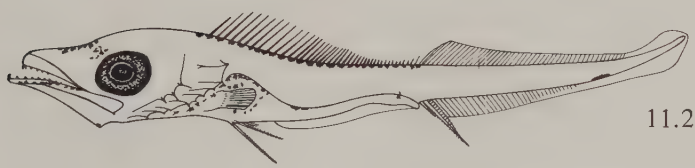
## *BENTHODESMUS*

A



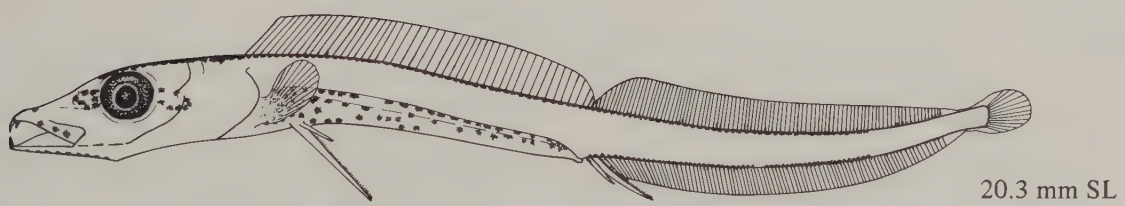

*(Benthodesmus* sp.*)*

B




*(Benthodesmus elongatus simonyi)*

C




*(Benthodesmus elongatus simonyi)*

Figure A, Collette et al. 1984b (Gulf of Mexico specimen); B, Gorbunova 1982b; C, Evseenko 1982 (B–C, redrawn; subspecies from North Atlantic).

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 30-31-31 | |
| | Precaudal: 14-14-15 | |
| | Caudal: 16-17-17 | |
| **Branchiostegal rays** | 7-7-7 | |
| **Caudal fin** | X, 9+8, X | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 5-5-5 |
| **Dorsal fin** | S: 9-10-12 | R: 11-12-12 |
| **Pectoral fin** | R: 20-20-20 | |
| **Anal fin** | S: 1-1-1 | R: 11-X-12 |
| **Gill rakers** | U: 11-13-14 | L: 27-28-30 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to SE Alaska, 55-59°N |
| **Ecology** | Epi- and mesopelagic, 0-300 m[a] |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Apr-July (California)[b] |
| | Area: 0-72 m, 3-32 km from shore[c] |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: >1 million (may spawn more than once each year)[b] |
| **Age at first maturity** | 2 yr[b]-6 yr[d] |
| **Longevity** | 10 yr[b]; 12 yr[e] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 0.9-1.3 mm |
| **No. of oil globules** | One, ventral |
| **Oil globule diameter** | 0.26 mm |
| **Yolk** | Homogeneous |
| **Envelope** | Smooth, clear |
| **Hatch size** | 3.3 mm SL |
| **Incubation time/temp.** | |

**Pigment**
- Oil globule
- Yolk

**Diagnostic characters**
- Posterior position of oil globule

### LARVAE

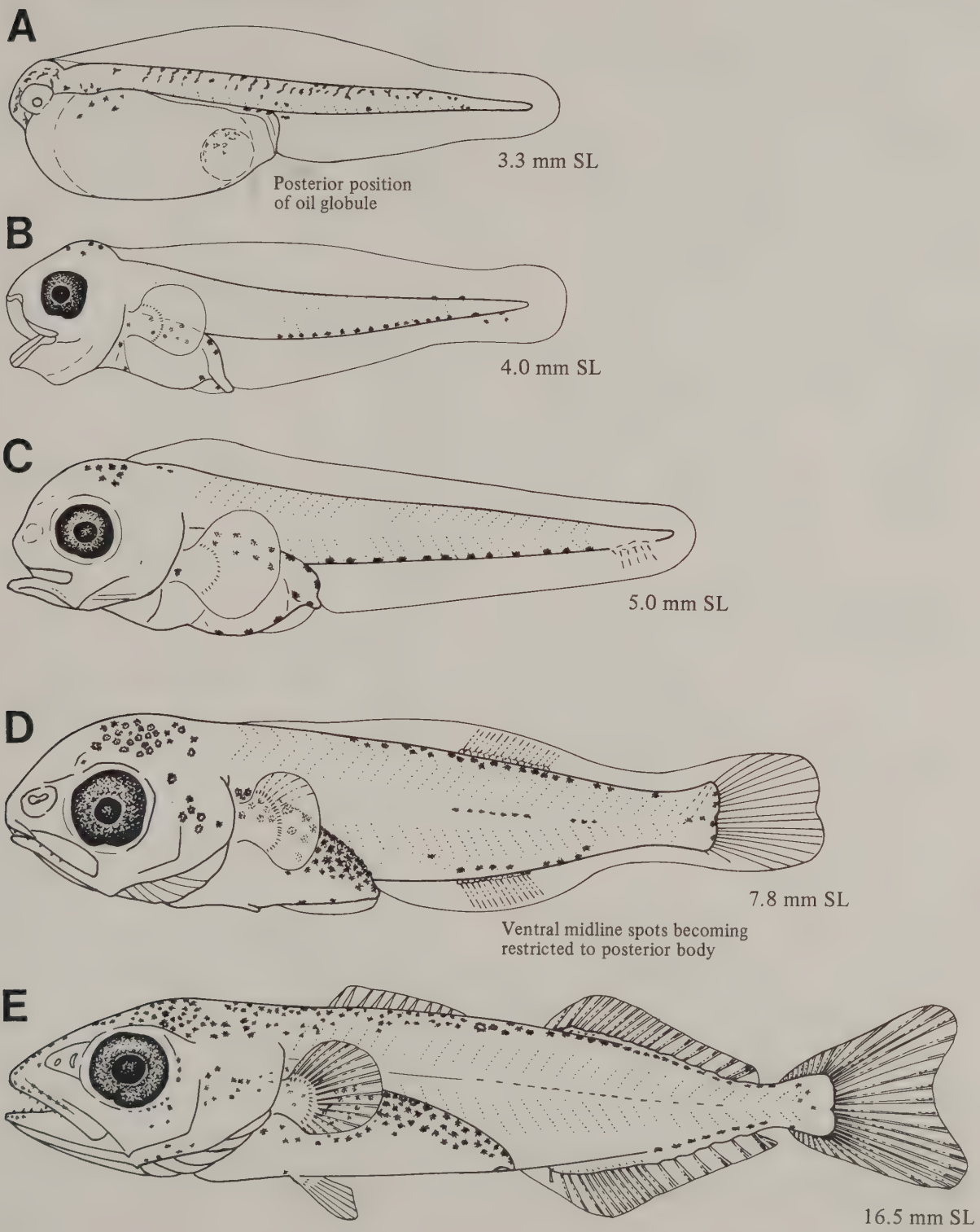
| | |
|---|---|
| **Preanal length** | 52%, increasing with development to 64% SL |
| **Length at flexion** | 6 mm SL |
| **Length at transformation** | 15 mm SL |
| **Sequence of fin development** | 2nd dorsal (rays) and anal, 1st dorsal (spines), pectorals and pelvics |

**Pigment**
- Pigment on crown extends anteriorly with development
- Dorsolaterally on gut
- Ventral midline
- Postflexion
  - —Short dorsal midline series develops under dorsal fin, spreading anteriorly
  - —Ventral midline becomes restricted to posterior half of body
  - —Mediolateral pigment

**Diagnostic characters**
- Large head with teeth
- Myomeres (30-31)
- Pigment pattern

[a] Collette and Nauen 1983
[b] Hart 1973
[c] Fritzsche 1978
[d] Schaefer 1980
[e] Fitch and Lavenberg 1971

Ref: Berrien 1978, Collette et al. 1984b, G.D. Johnson 1984, Kramer 1960.




Figures A–E, Kramer 1960 (redrawn).

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 22-22-23 | |
| | Precaudal: 10-10-10 | |
| | Caudal: 12-12-13 | |
| **Branchiostegal rays** | 5-X-6 | |
| **Caudal fin** | X, 16, X | |
| **Pelvic fin**[a] | Thoracic | |
| | S: 1-1-1 | R: 4-4-4 |
| **Dorsal fin**[a] | S: 2-2-2 | R: 24-24-24 |
| **Pectoral fin** | R: 17-X-20 | |
| **Anal fin**[a] | S: 14-X-17 | |
| **Gill rakers** | U: 4-X-6 | L: 11-X-14 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Washington, 46-48°30′N |
| **Ecology** | Epi- and mesopelagic |
| **ELH pattern** | Parity and eggs unknown, pelagic larvae |
| **Spawning** | Season: Spring-early summer[b] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

[a]Meristics for larvae and adults are different:

| | Larvae | Adults |
|---|---|---|
| Dorsal fin rays | 24 | 11-14 |
| Anal fin rays | 18 | 13-15 |
| Pelvic fin rays | 4 | absent |

[b]Fitch and Lavenberg 1971

[c]Based on illustrations only, specimens were not available.

[d]G.D. Johnson, Natl. Mus. Nat. Hist., Wash., D.C. 20560, pers. commun., 7 Nov. 1986.

Ref: Leis and Richards 1984, Nishikawa 1987.

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | <3.5 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

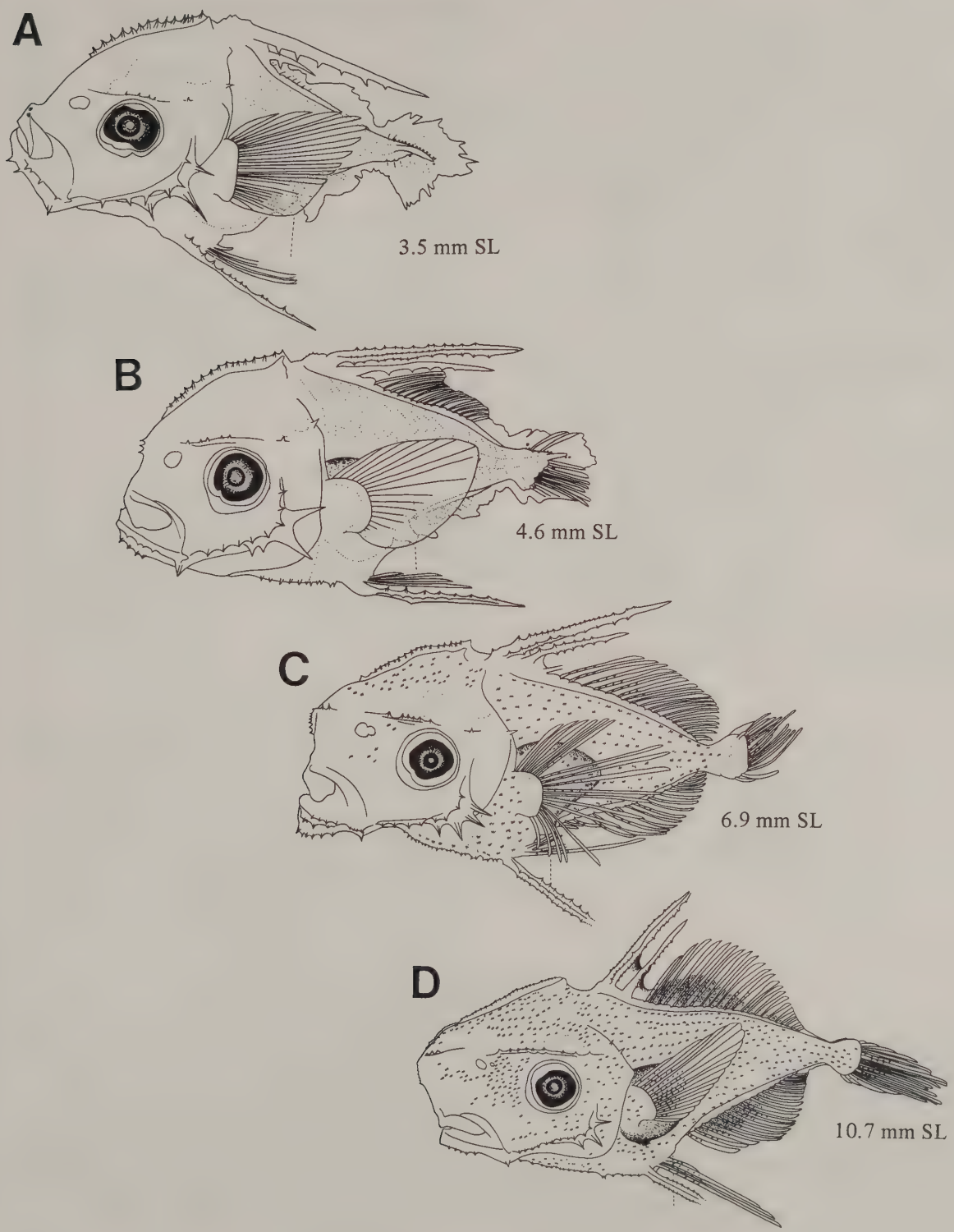
| | |
|---|---|
| **Preanal length** | ~60% SL, decreasing with development |
| **Length at flexion** | |
| **Length at transformation** | |
| **Sequence of fin development** | Pelvics and anterior dorsal fin spines form early |

**Pigment**[c]

- Few spots on upper jaw
- With development above urostyle
- Lightly on caudal fin, hypural region with several spots
- Gut
- With development on pectoral fin rays

**Diagnostic characters**

- Morphology
  - —Deep-bodied but not as kite-shaped as acanthurids
  - —Large square-shaped head with small terminal mouth
  - —Extensive head spination
  - —With development, minute spines on soft rays and along body surface
  - —Dorsal and pelvic spines elongate, finely serrated
  - —Loss of meristic elements with growth
- Not shown on figure[d]
  - —Spines on ascending process of premaxillary bone (important feature uniquely shared with *Zanclus canescens*, a closely related acanthuroid, and acanthurids)
  - —Small dorsal spine anterior to first dorsal spine appears later in development




Figures A–D, Nishikawa 1987 (western Pacific specimen).

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 56-59-62 | |
| | Precaudal: 22-24-25 (adults)[a] | |
| | Caudal: 33-35-38 | |
| **Branchiostegal rays** | 7-7-7 | |
| **Caudal fin** | 11-14, 9+8, 10-13 | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 5-5-5 |
| **Dorsal fin** | S: 3-3-3 | R: 34-39-43 |
| **Pectoral fin** | R: 18-X-21 | |
| **Anal fin** | S: 3-3-3 | R: 20-X-29 |
| **Gill rakers** | U: 4-X-6 | L: 12-X-14 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Gulf of Alaska, 54-60°N |
| **Ecology** | Epipelagic, 0-91 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.52-1.80 mm |
| **No. of oil globules** | One |
| **Oil globule diameter** | 0.30-0.44 mm (large) |
| **Yolk** | Homogeneous |
| **Envelope** | Clear, smooth |
| **Hatch size** | |
| **Incubation time/temp.** | |

**Pigment**

- Dorsal pigment along body
- Ventral pigment from head to tip of tail
- Underside of oil globule becomes pigmented with development

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 50-58% SL |
| **Length at flexion** | ~9.3-11.0 mm SL |
| **Length at transformation** | ~20 mm SL |
| **Sequence of fin development** | Caudal, 2nd dorsal (rays), anal, pectorals, 1st dorsal (spines), pelvics |

**Pigment**

- Dorsal and ventral body midline pigment
- Lateral line dashes develop during flexion
- Head and tail pigment increases with development
- Become heavily, uniformly pigmented including fin membranes

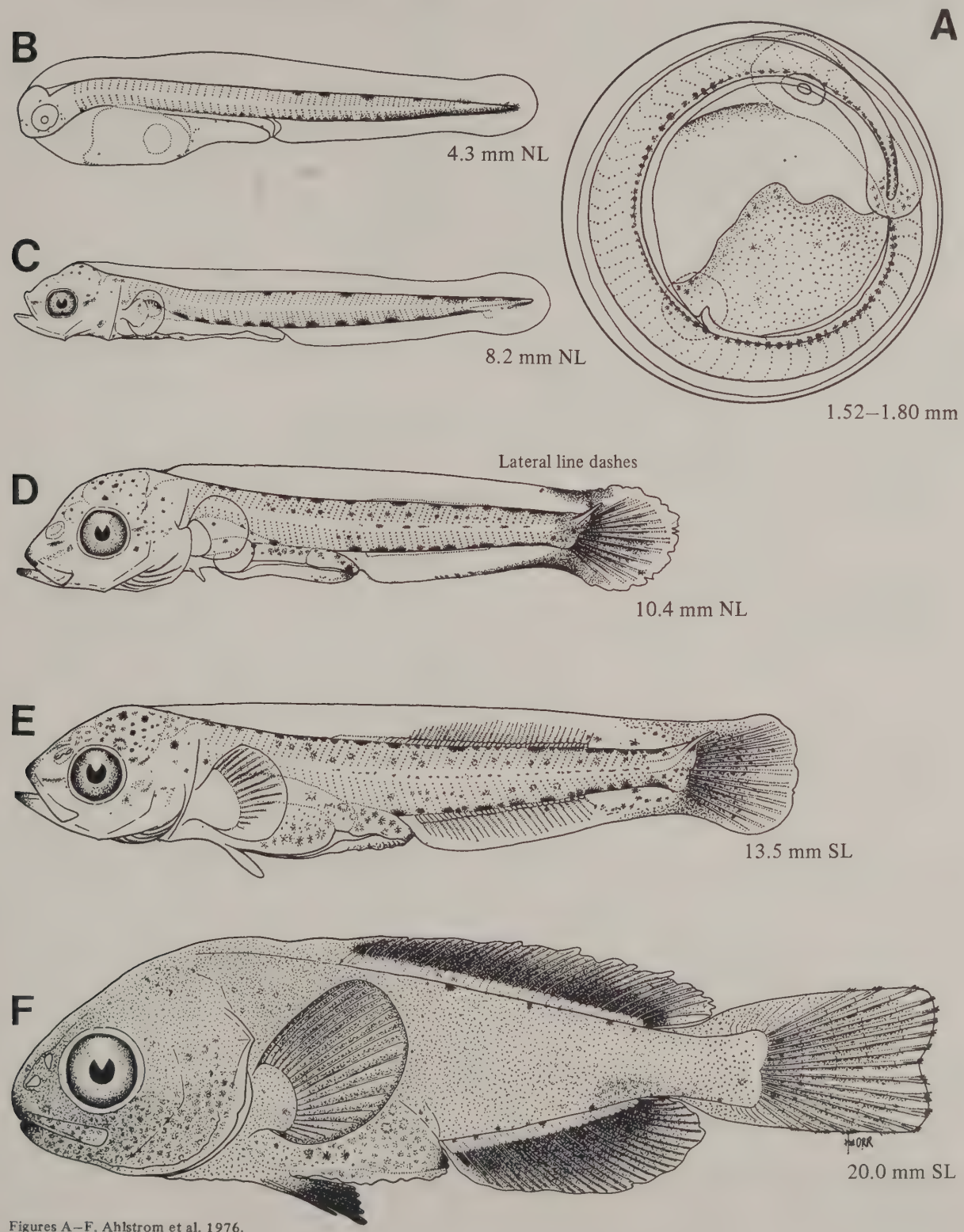
**Diagnostic characters**

Distinguished from *Tetragonurus cuvieri* (p. 560) by

- High myomere counts (56-62)
- Preflexion: Dorsal body pigment over posterior half of body; only on tail in *T. cuvieri*
- Flexion: No preopercular spines
- Postflexion
  - —Dorsal and anal spines weak, few (three) dorsal spines
  - —More dorsal and anal fin rays than in *T. cuvieri*

[a] Number of preanal myomeres appears to decrease with development (B. Sumida, NMFS Southwest Fish. Cent., P.O. Box 271, La Jolla, CA 92038, pers. commun., 16 Dec. 1986).

Ref: Ahlstrom et al. 1976, Horn 1984.




Figures A–F, Ahlstrom et al. 1976.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 52-53-57 | |
| | Precaudal: 25-28-29 (adults)[a] | |
| | Caudal: 24-26-28 | |
| **Branchiostegal rays** | 5-6-6 | |
| **Caudal fin** | 9-13, 9+8, 9-12 | |
| **Pelvic fin** | Thoracic | |
| | S: 1-1-1 | R: 5-5-5 |
| **Dorsal fin** | S: 15-17-21 | R: 10-12-17 |
| **Pectoral fin** | R: 14-X-17 | |
| **Anal fin** | S: 2-2-2 | R: 9-X-15 |
| **Gill rakers** | U: 6-6-6 | L: 7-X-14 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Aleutian Is., 51-55°N |
| **Ecology** | Epipelagic |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.10-1.28 mm |
| **No. of oil globules** | One |
| **Oil globule diameter** | 0.25-0.30 mm (amorphous) |
| **Yolk** | Homogeneous |
| **Envelope** | Smooth, golden |
| **Hatch size** | 4.0-4.1 mm SL |
| **Incubation time/temp.** | |

**Pigment**

- Oil globule
- Distinctive pigment on embryo; double dorsal line separating prior to head, outlining brain, and extending forward to snout
- Ventral pigment above digestive tract, continuing along tail

**Diagnostic characters**

- Pigment

### LARVAE

| | |
|---|---|
| **Preanal length** | 60-70% SL |
| **Length at flexion** | 7.6-10.1 mm SL |
| **Length at transformation** | ~21.4 mm SL |
| **Sequence of fin development** | Caudal; 2nd dorsal (rays), anal, and pectorals; 1st dorsal (spines); pelvics |

**Pigment**

- Tail
- Lateral line notable during flexion
- Eye bar
- Dorsal midline on caudal peduncle extending anteriorly with development

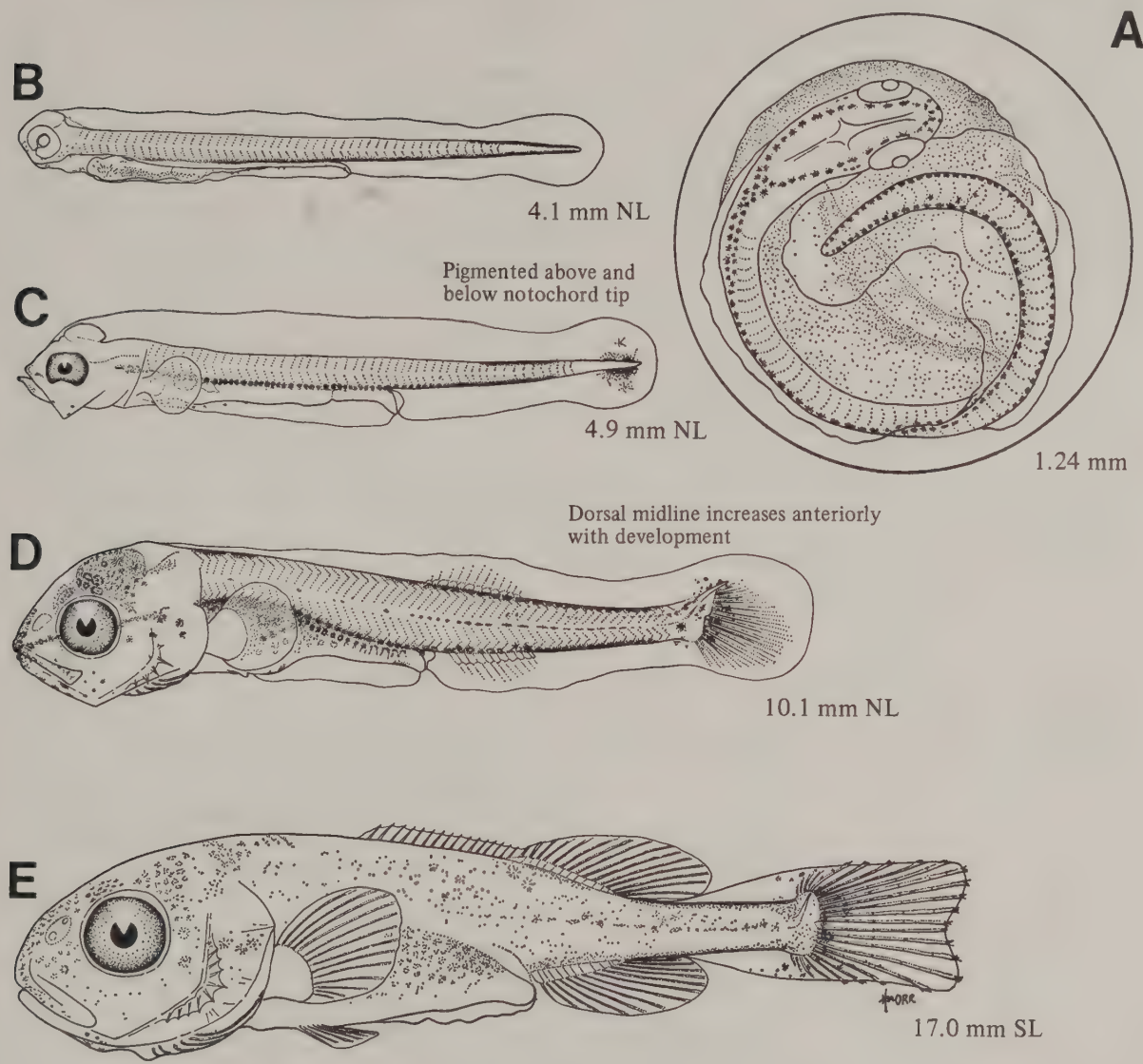
**Diagnostic characters**

Distinguished from *Icichthys lockingtoni* (p. 558) by

- Myomere count (52-57)
- Pigment
  —Notochord tip and base of caudal
  —Ventral row over gut to tail
- Early formation of opposing 2nd dorsal and anal fins
- Slender body with long caudal peduncle

[a] Number of preanal myomeres appears to decrease with development (B. Sumida, NMFS Southwest Fish. Cent., P.O. Box 271, La Jolla, CA 92038, pers. commun., 16 Dec. 1986).

Ref: Ahlstrom et al. 1976.




Figures A–E, Ahlstrom et al. 1976.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 28-30-31 | |
| | Precaudal: 11-13-14 (adults)[a] | |
| | Caudal: 17-17-19 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | 7-9, 9+8, 6-8 | |
| **Pelvic fin** | Absent | |
| **Dorsal fin** | S: 2-3-4 | R: 41-45-48 |
| **Pectoral fin** | R: 19-21-23 | |
| **Anal fin** | S: 2-3-3 | R: 35-39-44 |
| **Gill rakers** | U: 3-3-3 | L: 11-11-11 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Brit. Col., 48°30′-55°N |
| **Ecology** | Epipelagic, 9-91 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Spring-summer (California)[b] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | |
| **No. of oil globules** | One |
| **Oil globule diameter** | 0.2 mm (in yolksac larva) |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | 1.8-2.0 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | 55%, with development decreasing to 44% SL |
| **Length at flexion** | 5-7 mm SL |
| **Length at transformation** | ~20 mm SL |
| **Sequence of fin development** | |

**Pigment**

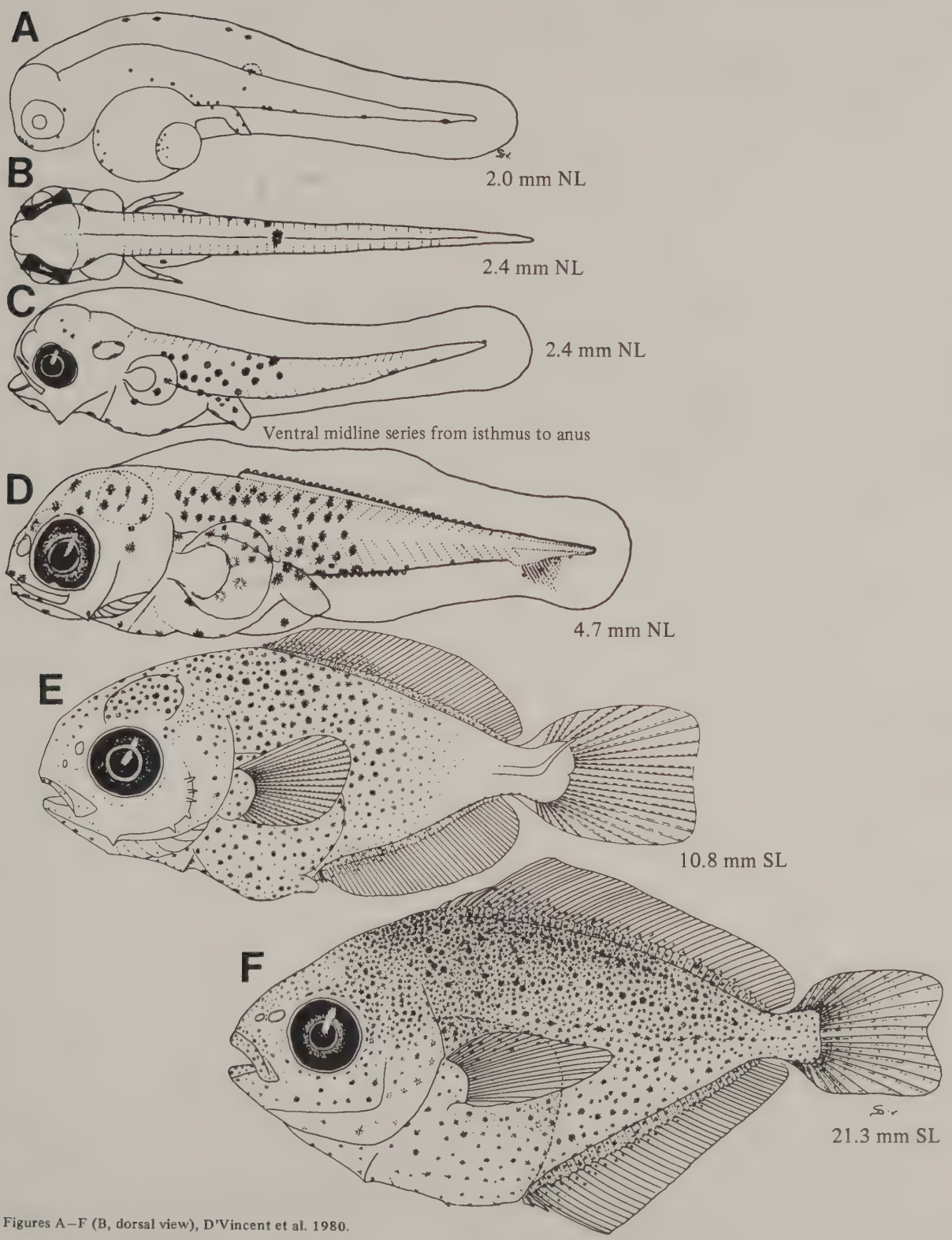
- Anterior body
- Median ventral series of melanophores from isthmus to anus
- Large melanophores on head and anterior half of body, becoming uniformly pigmented on anterior 3/4 of body, later over whole body

**Diagnostic characters**

- Pigment
- Increase in relative body depth during ontogeny
- Absence of pelvic fins

[a] Number of preanal myomeres appears to decrease with development (B. Sumida, NMFS Southwest Fish. Cent., P.O. Box 271, La Jolla, CA 92038, pers. commun., 16 Dec. 1986).
[b] Fitch and Lavenberg 1971

Ref: D'Vincent et al. 1980.




Figures A–F (B, dorsal view), D'Vincent et al. 1980.

## Pleuronectiformes

Pleuronectiforms are benthic fishes that are asymmetrical with both eyes on one side of the head. Asymmetry is also reflected in dentition, cranial osteology, pelvic fin placement and morphology, pigment, and squamation. Worldwide in distribution, there are 7 families, with well over 120 genera and 500 species (Ahlstrom et al. 1984a). Most families are defined as dextral (eyes on right side) or sinistral (eyes on left side), although some species are indiscriminate. A total of 3 families with 31 species occur in the study area. Much is known about the early life history of many species. Eggs of most are pelagic, spherical, and have homogeneous yolks. Chorions may be smooth, striated, or ornamented with raised polygonal patterns (Ahlstrom et al. 1984a). Early larvae are bilaterally symmetrical and swim upright. Of help in larval identification are body shape (short gut, elongate body), pigment patterns (postanal bands, pigment on the urostyle and finfolds), and meristic characters. Size at transformation and the development of spines and elongate dorsal or pelvic fin rays can be diagnostic. During transformation, the eyes migrate to their adult position and the larvae assume the distinctive flat profile unique to the order. At this point, juveniles settle and become benthic inhabitants.

Families in study area: **Paralichthyidae**
**Pleuronectidae**
**Cynoglossidae**

## Table 49

**Characters useful in identifying pleuronectiform larvae. Size data are after Ahlstrom et al. (1984a), in part. All measurements are in millimeters NL or SL. Taxa listed alphabetically within families.**

| Species[a] | Size at hatching | Size at notochord flexion | Size at transformation | Total myomeres |
|---|---|---|---|---|
| **Paralichthyidae** | | | | |
| *Citharichthys sordidus* | 2.0 | 10.0-11.4 | 20.0-39.0 | 39-40 |
| *C. stigmaeus* | 2.0 | 9.2-10.2 | 24.0-36.0 | 36-39 |
| **Pleuronectidae** | | | | |
| *Acanthopsetta nadeshnyi* | <3.0 | 8.4-9.9 | 20.0-24.0 | 39-40[b] |
| *Atheresthes evermanni* | <8.4 | 11.5-15.0 | — | — |
| *A. stomias* | <10.0 | 10.0-12.0 | 33.0- ? | 47-50 |
| *Clidoderma asperrimum* | — | — | — | 42-44[b] |
| *Embassichthys bathybius* | 9.0 | 15.4-16.2 | 16.2- ? | 57-65 |
| *Eopsetta jordani* | 2.8 | — | — | 41-45 |
| *Glyptocephalus stelleri* | 4.1-5.2 | 15.0-17.0 | 19.0-48.0 | 52-60 |
| *G. zachirus* | 5.0-6.0 | 15.3-24.0 | 49.0-72.0 | 63-66 |
| *Hippoglossoides elassodon* | 5.3-6.9 | 9.0-10.2 | 18.0- ? | 43-47 |
| *H. robustus* | 4.0 | 11.0- ? | >28.6 | 44 |
| *Hippoglossus stenolepis* | 7.8-8.5 | 13.6-17.8 | 14.7-24.1 | 49-51 |
| *Inopsetta ischyra* | — | — | — | 41 |
| *Isopsetta isolepis* | 2.7-2.9 | 9.1-14.0 | 15.0->21.9 | 41-42 |
| *Lepidopsetta bilineata* | 3.4-4.0 | 8.4-9.9 | >17.7 | 39-42 |
| *Limanda aspera* | 2.2-2.8 | 7.5-9.5 | 10.0- ? | 40-41 |
| *L. proboscidea* | <4.8 | — | — | — |
| *Liopsetta glacialis* | 3.7 | — | — | 37-41 |
| *Lyopsetta exilis* | 5.6 | 9.0-10.9 | 15.7-24.7 | 43-47 |
| *Microstomus pacificus* | 6.0 | 10.0-15.0 | 20.0->45.0 | 50-55 |
| *Parophrys vetulus* | 2.3-2.8 | 8.8-10.5 | 17.5- ? | 42-47 |
| *Platichthys stellatus* | 1.9-2.1 | 5.5-6.0 | 8.0- ? | 35-38 |
| *Pleuronectes quadrituberculatus* | 5.6 | 8.0-10.0 | 10.0- ? | 41-42 |
| *Pleuronichthys coenosus* | 3.9 | 6.2-8.5 | 8.2->11.4 | 37-39 |
| *P. decurrens* | 4.9-5.5 | 7.8-11.0 | 10.5->21.0 | 38-41 |
| *Psettichthys melanostictus* | <3.0 | 8.0-10.0 | >22.6 | 38-41 |
| *Reinhardtius hippoglossoides* | 10.0-16.0 | 25.0-27.0 | 45.0-65.0 | 61-64 |
| **Cynoglossidae** | | | | |
| *Symphurus atricauda* | 1.9 | 9.4-10.8 | 19.0-24.2 | 50-52 |

[a] The following nomenclatural changes have been recommended by Sakamoto (1984):

*Glyptocephalus* (= *Errex*) *zachirus* — *Liopsetta* (= *Pleuronectes*)
*Isopsetta* (= *Pleuronectes*) — *Parophrys* (= *Pleuronectes*)
*Lepidopsetta* (= *Pleuronectes*) — *Lyopsetta* (= *Eopsetta*)
*Limanda* (= *Pleuronectes*)

[b] M. Okiyama, Ocean Res. Inst., Univ. Tokyo, 1-15-1 Minamidai, Nakano-Ku, Tokyo 164, Japan, pers. commun., 17 Oct. 1986.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 39-X-40 |
| | Precaudal: 11-11-12 |
| | Caudal: 27-28-29 |
| **Branchiostegal rays** | 6-X-7 |
| **Caudal fin** | X, 7+6, X |
| | Total rays=17[a] |
| **Pelvic fin** | Thoracic |
| | R: 6-6-6 |
| **Dorsal fin** | R: 86-91-102 |
| **Pectoral fin** | R: 12-12-12 |
| **Anal fin** | R: 67-72-81 |
| **Gill rakers** | U: 6-X-9 L: 12-13-16 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Bering Sea, 54-66°N |
| **Ecology** | Epi-, meso-, and bathybenthal, 0-549 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Mar-May (Puget Sound)[b]; July-Sept (Calif.; may spawn twice each season)[c] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | 2-3 yr[b] |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 0.55-0.77 mm;[c] 0.51-0.79 mm[d] |
| **No. of oil globules** | One |
| **Oil globule diameter** | 0.09-0.12 mm |
| **Yolk** | Homogeneous |
| **Envelope** | Smooth |
| **Hatch size** | ~2.0 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

We cannot identify *Citharichthys* spp. eggs to species. We collect two types of paralichthyid eggs: the first type has an average diameter of ~0.64-0.68 mm, and the other type averages ~0.78-0.88 mm.

### LARVAE[e]

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | <10.0-11.4 mm SL |
| **Length at transformation** | 20->39 mm SL |
| **Sequence of fin development** | Dorsal, anal, caudal, pelvics, pectorals or caudal, dorsal and anal, pelvics, pectorals |

**Pigment**

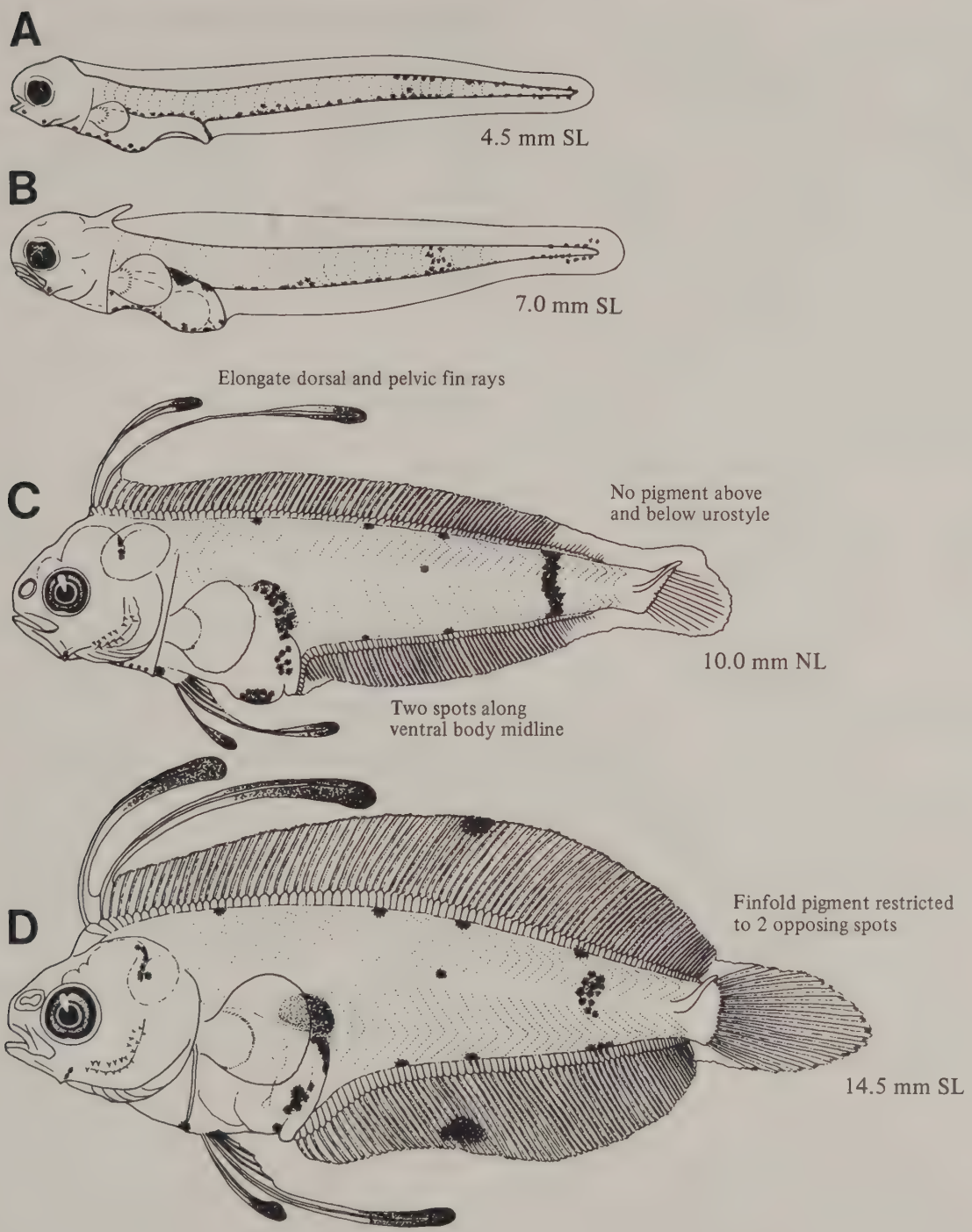
- Ventral body midline pigment posterior to anus, coalesces later into two melanophores
- Band at 3/4 BL
- Posteriorly on gut
- Tips of elongate dorsal and pelvic fin rays

**Diagnostic characters**

- Elongate dorsal and pelvic fin rays

[a] 11 branched rays.
[b] Smith 1936
[c] Arora 1951
[d] Ahlstrom et al. 1984a
[e] Early preflexion larvae (<6-7 mm SL) of *C. sordidus* and *C. stigmaeus* are not identifiable to species until the elongate dorsal fin rays form on *C. sordidus* (~7 mm SL). Preflexion larvae collected in our study area do not resemble the published illustrations of either species (Ahlstrom and Moser 1975); they have ventral gut pigment extending more anteriorly, a series of postanal ventral midline melanophores, no finfold pigment, and less intense caudal pigment (Fig. A). Specimens >6.9 mm SL that have elongated dorsal fin rays are *C. sordidus* (Fig. B), but do not exhibit the intense caudal pigment shown by Ahlstrom and Moser (1975). Our specimens indicate a decrease in intensity of caudal pigment with development for *C. sordidus* and an increase for *C. stigmaeus*. The preflexion larva of *C. sordidus* illustrated by Ahlstrom and Moser (1975) may belong to another species probably south of our study area, most likely *C. xanthostigma* (B. Sumida, NMFS Southwest Fish. Cent., Box 271, La Jolla, CA 92038, pers. commun., 16 Dec. 1986).

Ref: Ahlstrom 1965, Ahlstrom and Moser 1975, Ahlstrom et al. 1984a.




Figures A–B, NWAFC originals (B. Vinter); C–D, Ahlstrom and Moser 1975.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 36-37-39 |
| | Precaudal: 9-10-10 |
| | Caudal: 27-28-29 |
| **Branchiostegal rays** | 6-X-7 |
| **Caudal fin** | 2, 7+6, 2 |
| | Total rays=17[a] |
| **Pelvic fin** | Thoracic |
| | R: 6-6-6 |
| **Dorsal fin** | R: 75-84-97 |
| **Pectoral fin** | R: 12-12-12 |
| **Anal fin** | R: 58-64-77 |
| **Gill rakers** | U: 3-X-5 L: 7-8-10 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to SE Alaska, 55-59°N |
| **Ecology** | Epi- and mesobenthal, 0-366 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Spring-summer (Calif.)[b] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 0.75-0.83 mm |
| **No. of oil globules** | One |
| **Oil globule diameter** | 0.09-0.10 mm |
| **Yolk** | Homogeneous |
| **Envelope** | Smooth |
| **Hatch size** | 2 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

See notes on *C. sordidus* (p. 568)

### LARVAE

| | |
|---|---|
| **Preanal length** | |
| **Length at flexion** | 9.2-10.2 mm SL |
| **Length at transformation** | 24.0-35.5 mm SL |
| **Sequence of fin development** | Dorsal, anal, caudal, pelvics, pectorals or caudal, dorsal and anal, pelvics, pectorals |

**Pigment** (see *C. sordidus*)

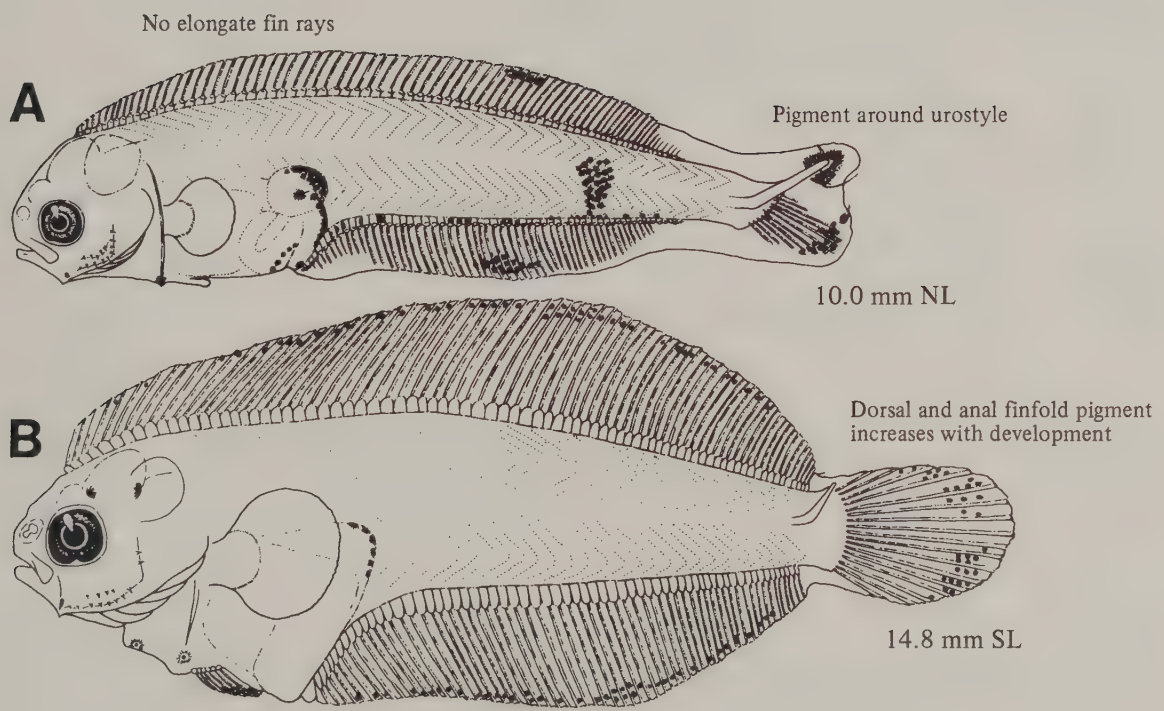
- Urostyle pigment increases in intensity to flexion stage, then fades
- Small melanophores along ventral body midline posterior to anus; these migrate onto anal fin pterygiophores in postflexion larvae
- Band at 3/4 BL, lost after flexion
- Caudal fin

**Diagnostic characters**

- Lack of elongate fin rays

[a] 11 branched rays.
[b] Ahlstrom and Moser 1975

Ref: Ahlstrom et al. 1984a.




Figures A–B, Ahlstrom and Moser 1975.

The majority of species in the order (27 out of a total of 31) belong to the family Pleuronectidae. Ahlstrom et al. (1984a) summarize the following ontogenetic characters for the family.

Egg size ranges from 0.66 to 4.50 mm, yolk is homogeneous, oil globules are absent in most species, and the chorion is smooth (exceptions include *Pleuronichthys ritteri* and *P. cornutus*). Some light sculpturing of the chorion is seen in several species.

Larvae hatch from 1.7 to 16.0 mm SL. They possess no elongate dorsal or pelvic fin rays, gut is normal, and spines are limited to the preopercular, otic, and frontal regions, although absent in most.

The caudal fin ray count is not stabilized within pleuronectids, in contrast to most other taxa. Most pleuronectids have 17-19 total caudal fin rays (18 is most common). Within species there is variability in the total fin ray count and in the number of rays that are branched. Since variability exists, total counts, number of branched rays, and principal and secondary rays are given when available.

**Table 50**

**Pigment characters and myomere counts that may be useful in the identification of pleuronectid larvae during the preflexion and early flexion stages.***

| | Pigment characters | | | | | |
|---|---|---|---|---|---|---|
| | | | | Finfold | | |
| Genus | Number of bands | Slashlike hypaxial pigment | Urostyle | Dorsal | Anal | Total myomeres |
| **Postanal pigment bands present** | | | | | | |
| *Embassichthys* | 3 | No | Yes | Yes | Yes | 57-65 |
| *Eopsetta* | 2 | No | Yes | No | No | 41-45 |
| *Glyptocephalus* | 3-4 | No | Yes | Yes/no | Yes/no | 52-66 |
| *Hippoglossoides* | 3-4 | Yes | Yes | Yes | Yes | 44-51 |
| *Isopsetta* | 3 | No | Yes | No | Yes | 41-42 |
| *Lepidopsetta* | 1 | No | No, few spots | Yes | Yes | 39-42 |
| *Microstomus* | 4 | No | Yes | Yes | Yes | 50-55 |
| **Postanal pigment bands absent** | | | | | | |
| *Acanthopsetta* | — | Yes | Yes | No | No | 39-40 |
| *Atheresthes* | — | No | Yes/no | No | No | 47-50 |
| *Hippoglossus* | — | No | Yes | Yes | Yes | 49-51 |
| *Limanda* | — | Yes | No | No | Yes | 40-41 |
| *Liopsetta* | — | No | Yes | No | No | 37-41 |
| *Lyopsetta* | — | Yes | Yes | Yes | Yes | 43-47 |
| *Parophrys* | — | Yes | Yes | No | Yes | 42-47 |
| *Platichthys* | — | No | Yes | Yes | Yes | 35-38 |
| *Pleuronectes* | — | No | No | No | Yes | 41-42 |
| *Pleuronichthys* | — | No | Yes | Yes | Yes | 38-41 |
| *Psettichthys* | — | No | Yes | Yes | Yes | 38-41 |
| *Reinhardtius* | — | No | Yes | Yes | Yes | 61-64 |

*Characters are discussed only for taxa where at least some early-life-history stages are known. Only general trends are presented since pigment may vary from specimen to specimen. In cases where actual specimens were not available, subjective decisions were made based on previously published illustrations.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 39-X-42 |
| | Precaudal: 9-X-10 |
| | Caudal: 30-X-31 |
| **Branchiostegal rays** | 7-X-8 |
| **Caudal fin** | Total rays = 18 |
| **Pelvic fin** | Thoracic |
| | R: 6-6-6 |
| **Dorsal fin** | R: 67-X-78 |
| **Pectoral fin** | R: 9-X-11 |
| **Anal fin** | R: 54-X-62 |
| **Gill rakers** | U: X-X-X L: 10-X-12 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Bering Sea, 54-66°N |
| **Ecology** | Epi- and mesobenthal |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Summer[a] |
| | Area: Deep water[a] |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 0.86-1.03 mm (0.92 mm) |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | Smooth |
| **Hatch size** | <3 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | 8.4-9.9 mm SL |
| **Length at transformation** | ~20-24 mm SL |
| **Sequence of fin development** | Caudal, dorsal and anal, pelvics, pectorals |

**Pigment**

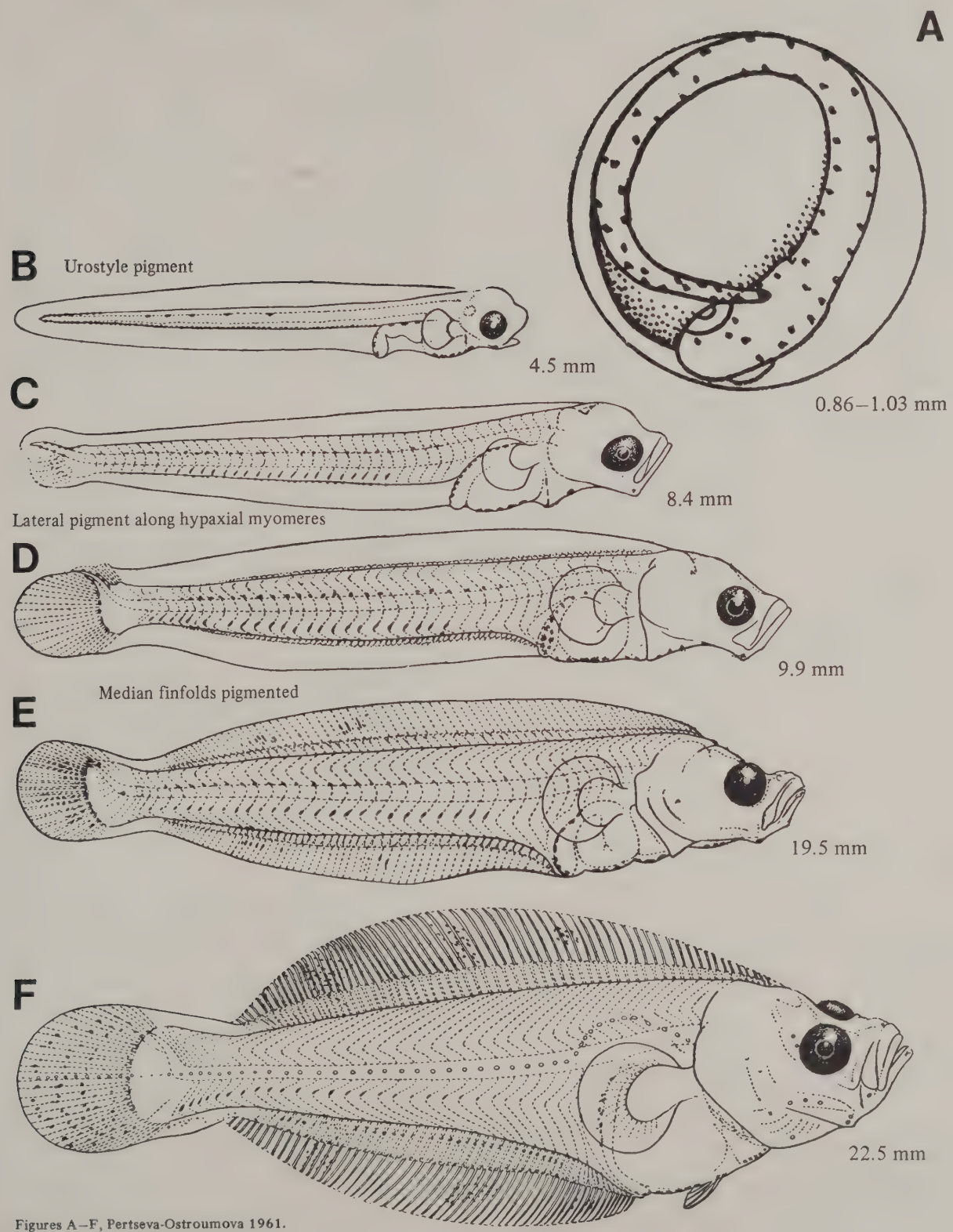
- Series of ventral midline melanophores extending around urostyle
- Several spots above notochord, number increases with development
- During flexion, pigment develops along hypaxial myomeres
- Initially, gut pigment restricted to dorsal and anteroventral surface; with development it extends posterodorsally and along ventral surface

**Diagnostic characters**

- Pigment
  - —Pigment pattern without bands
  - —Presence of hypaxial pigment
  - —Presence of pigment around urostyle

[a] Pertseva-Ostroumova 1961

Ref: Ahlstrom et al. 1984a, Pertseva-Ostroumova 1961.




Figures A–F, Pertseva-Ostroumova 1961.

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 49-X-52 | |
| | Precaudal: 10-X-11 | |
| | Caudal: 39-X-41 | |
| **Branchiostegal rays** | 7-X-8 | |
| **Caudal fin** | | |
| **Pelvic fin** | Thoracic | |
| | R: 6-6-6 | |
| **Dorsal fin** | R: 95-107-112 | |
| **Pectoral fin** | R: 13-X-14 | |
| **Anal fin** | R: 75-X-92 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Gulf of Alaska, 54-60°N, to Bering Sea, 54-66°N |
| **Ecology** | Epi- and mesobenthal |
| **ELH pattern** | Oviparous, bathypelagic eggs, pelagic larvae |
| **Spawning** | Season: Fall-winter[a] |
| | Area: Demersal, deep water[a] |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: 130,000-500,000[a] |
| **Age at first maturity** | 9-10 yr (females)[a] |
| | 6-7 yr (males)[a] |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 2.05-2.20 mm; 2.5-3.5 mm[a] |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | Greenish yellow |
| **Envelope** | Thin, smooth, clear |
| **Hatch size** | <8.4 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | |
| **Length at flexion** | ~11.5-15.0 mm SL |
| **Length at transformation** | |
| **Sequence of fin development** | Caudal, dorsal and anal, pelvics, pectorals |

**Pigment**

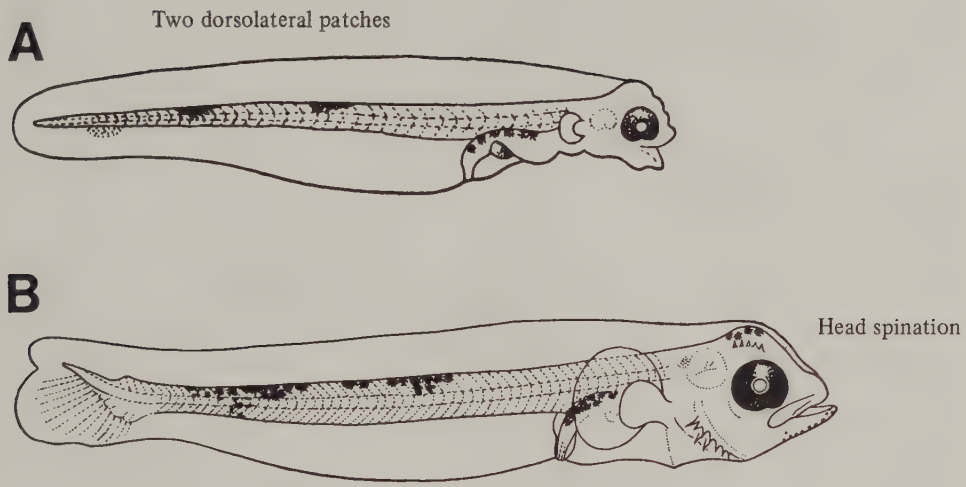
- Two dorsolateral patches which, with development, meet and extend over the caudal peduncle

**Diagnostic characters**

According to figures in Pertseva-Ostroumova (1961), pigment pattern and morphology are similar to *A. stomias*. No larvae of *A. evermanni* have been identified from the study area.

[a] Pertseva-Ostroumova 1961

Ref: Ahlstrom et al. 1984a, Pertseva-Ostroumova 1961.




Figures A–B, Pertseva-Ostroumova 1961 (sizes not given).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 47-49-50 |
| | Precaudal: 12-12-12 |
| | Caudal: 35-37-38 |
| **Branchiostegal rays** | 7-X-8 |
| **Caudal fin** | Total rays = 17[a] |
| **Pelvic fin** | Thoracic |
| | R: 6-6-6 |
| **Dorsal fin** | R: 92-108-115 |
| **Pectoral fin** | R: 14-X-15 |
| **Anal fin** | R: 72-87-99 |
| **Gill rakers** | U: 4-4-4 L: 11-X-13 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Cent. California, 34-38°N, to Bering Sea, 54-66°N |
| **Ecology** | Epi-, meso-, and bathybenthal, 18-900 m |
| **ELH pattern** | Oviparous, mesopelagic eggs, mesopelagic larvae |
| **Spawning** | Season: Dec-Mar (Bering Sea);[b] Aug (Gulf of Alaska)[c] |
| | Area: 108-360 m[c] |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | 20 yr[d] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | ~3 mm |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | Smooth |
| **Hatch size** | |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | ~10-12 mm SL |
| **Length at transformation** | 25.6-33.0 mm SL |
| **Sequence of fin development** | Caudal, dorsal and anal, pelvics, pectorals |

**Pigment**

- Pigment on midbrain, spreading with development to dorsal surface of head, lower jaw, opercle
- Dorsally on gut, spreading laterally with development
- Two dorsolateral patches which, with development, meet and increase in size to cover caudal peduncle posteriorly

**Diagnostic characters**

Distinguished from other pleuronectids by

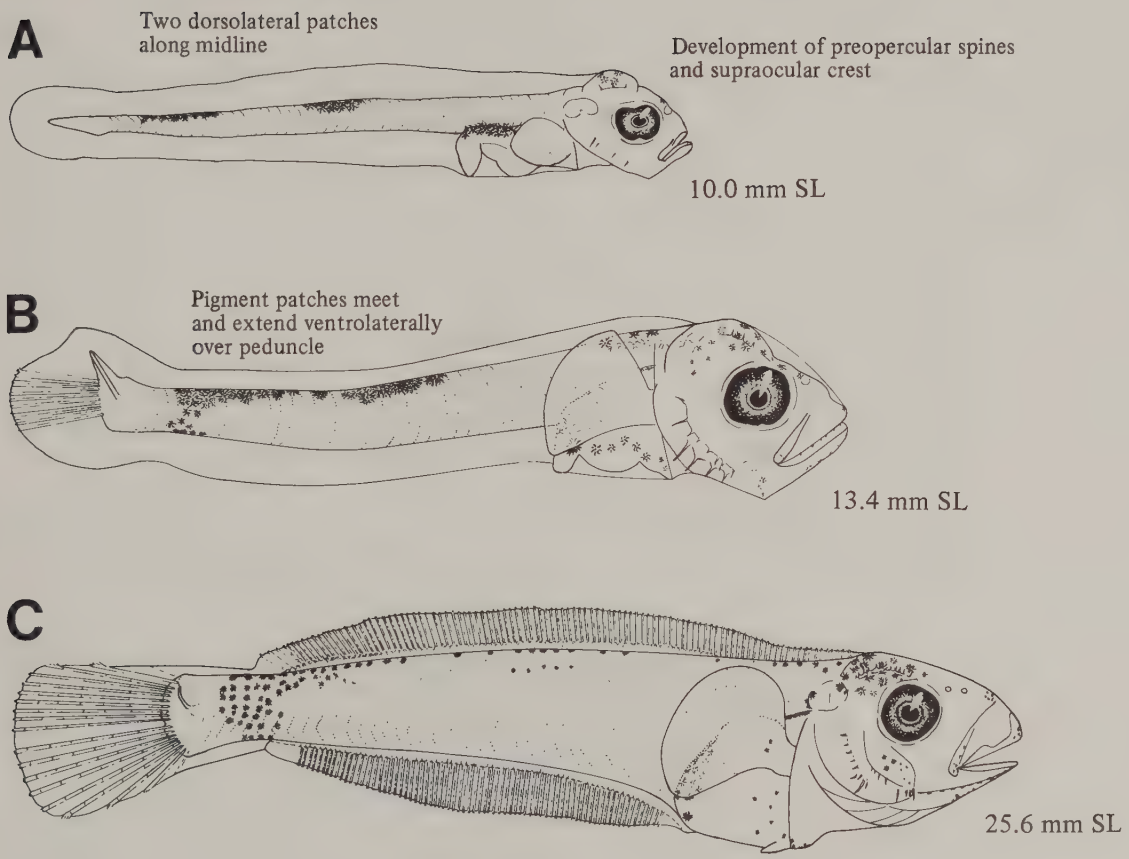
- Head spination: Early development of preopercular spines
- Pigmented supraocular crest
- Pigment pattern without bands; two dorsal patches with a lack of ventral pigment
- Head and snout blunt

Distinguished from *A. evermanni* by

- See *A. evermanni* (p. 576)

[a] 13 branched rays.
[b] Pertseva-Ostroumova 1961
[c] Hirschberger and Smith 1983
[d] Kabata and Forrester 1974

Ref: Ahlstrom et al. 1984a, Pertseva-Ostroumova 1961.




Figures A–C, NWAFC originals (B. Vinter).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 57-62-65 |
| | Precaudal: 13-14-14 |
| | Caudal: 44-48-51 |
| **Branchiostegal rays** | 7-X-8 |
| **Caudal fin** | X, 10+9, X |
| | Total rays = 19-21[a] |
| **Pelvic fin** | Thoracic |
| | R: 5-X-6 |
| **Dorsal fin** | R: 109-X-117 |
| **Pectoral fin** | R: 11-11-11 |
| **Anal fin** | R: 94-X-98 |
| **Gill rakers** | U: 6-X-9 L: 14-X-16 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Bering Sea, 54-66°N |
| **Ecology** | Meso- and bathybenthal, 320-1433 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Spring (possibly winter-spring)[b] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

[a] 17 branched rays.
[b] Richardson 1981b
[c] According to Figures C and E from Richardson (1981b), flexion occurs rapidly between 15.4 and 16.2 mm SL. However, the 18.5-mm NL specimen (Fig. D) illustrated by Ahlstrom et al. (1984a) does not appear fully flexed. Differences in size may be a result of preservation.

Ref: Ahlstrom et al. 1984a, Richardson 1981b.

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 2.8-3.1 mm |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous |
| **Envelope** | Smooth |
| **Hatch size** | ~9 mm SL |
| **Incubation time/temp.** | |

**Pigment**
- Eye
- Hindgut extending out into yolk
- Three postanal bands

**Diagnostic characters**
- Size
- Pigment pattern

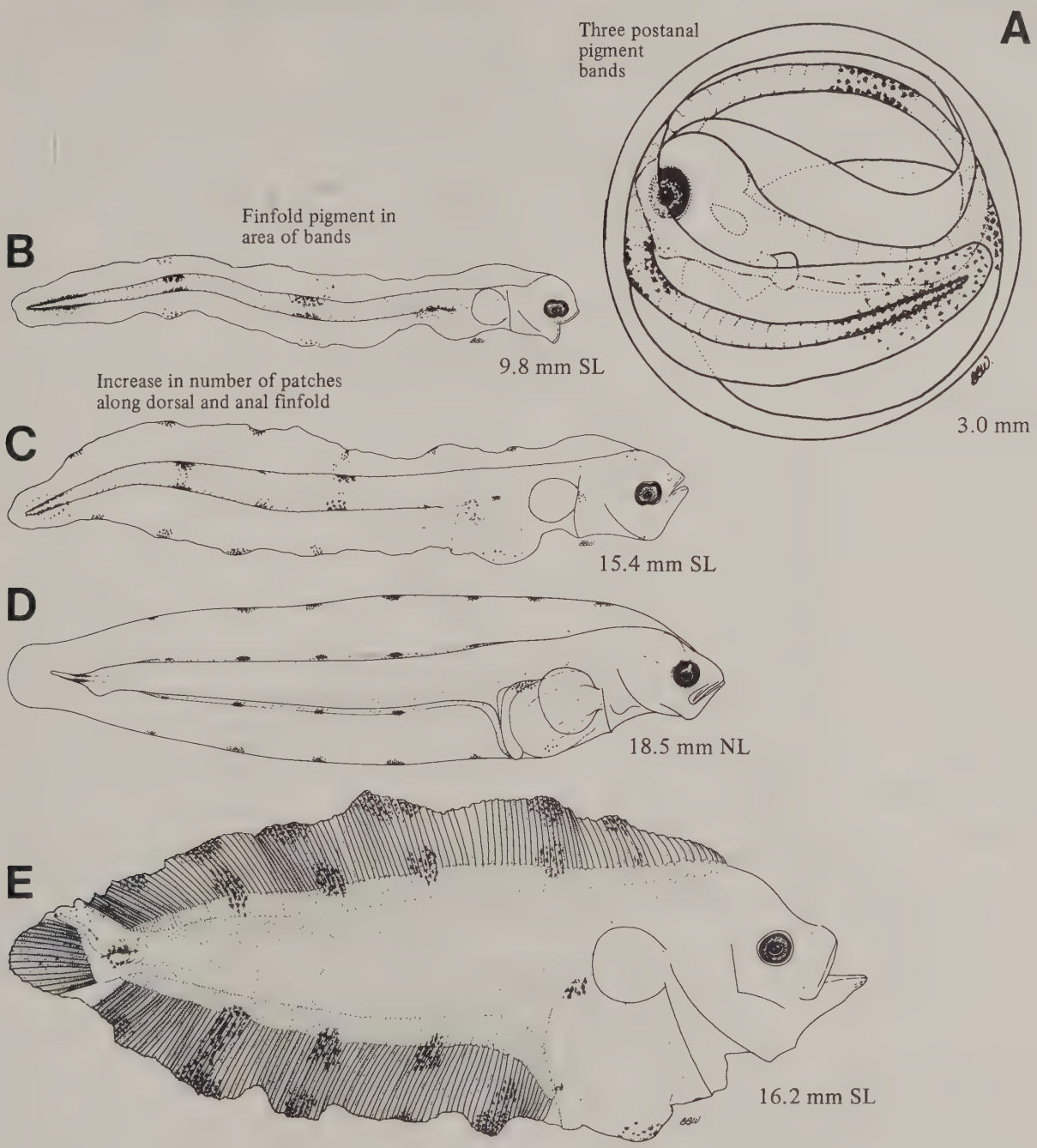
### LARVAE

| | |
|---|---|
| **Preanal length** | 40% SL |
| **Length at flexion** | 15.4-16.2 mm SL[c] |
| **Length at transformation** | >16.2 mm SL when eye migration commences |
| **Sequence of fin development** | Caudal, dorsal, and anal; pelvics; pectorals |

**Pigment**
- Initially, three postanal bands with pigment on the finfold in region of bands; number of dorsal and ventral spots change with size and stage of development
- Pigmentation increases with development along finfold margin (~7 spots along dorsal and 5 spots along anal in flexion larvae)

**Diagnostic characters**
- Postanal band pattern in preflexion larvae (three bands)
- High myomere count (57-65)

Distinguished from similar larvae with high myomere count by
- Presence of three postanal pigment bands and median finfold pigment
  - —*Reinhardtius hippoglossoides* (p. 622): Lightly pigmented and without bands
  - —*Glyptocephalus* spp. (p. 584, 586): Three bands (more laterally intense) in *G. stelleri*; in *G. zachirus*, caudal band, no finfold pigment
  - —Unidentified ophidiid larvae (p. 213): More myomeres (>75), less finfold pigment, and less pronounced loop in gut




Figures A–C, E, Richardson 1981b; D, Ahlstrom et al. 1984a.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 41-X-45 |
| | Precaudal: 11-11-11 |
| | Caudal: 30-32-34 |
| **Branchiostegal rays** | 7-X-8 |
| **Caudal fin** | X, 9+8, X |
| | Total rays=19[a] |
| **Pelvic fin** | Thoracic |
| | R: 6-6-6 |
| **Dorsal fin** | R: 82-97-103 |
| **Pectoral fin** | R: 13-13-13 |
| **Anal fin** | R: 67-73-79 |
| **Gill rakers** | U: X-X-X L: 15-X-17 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Gulf of Alaska, 54-60°N |
| **Ecology** | Epi-, meso-, and bathybenthal, 0-550 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Dec-Apr[b] |
| | Area: Off continental slope, 274-366 m[c] |
| | Mode: |
| | Migration: To deep water for spawning[c] |
| **Fecundity** | Range/function: 400,000-1,200,000[d] |
| **Age at first maturity** | 3-8 yr (females)[c] |
| | 4-9 yr (males)[c] |
| **Longevity** | 25 yr (females)[c] |
| | 21 yr (males)[c] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.21-1.25 mm |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | 2.8 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE[e]

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | |
| **Length at transformation** | |
| **Sequence of fin development** | |

**Pigment**

- Unpigmented at hatching
- Preflexion
  - —Midbody patch and urostyle pigment
  - —Melanophores on body over anus
  - —Posteriorly on gut and on head
- Flexion and early postflexion larvae are undescribed

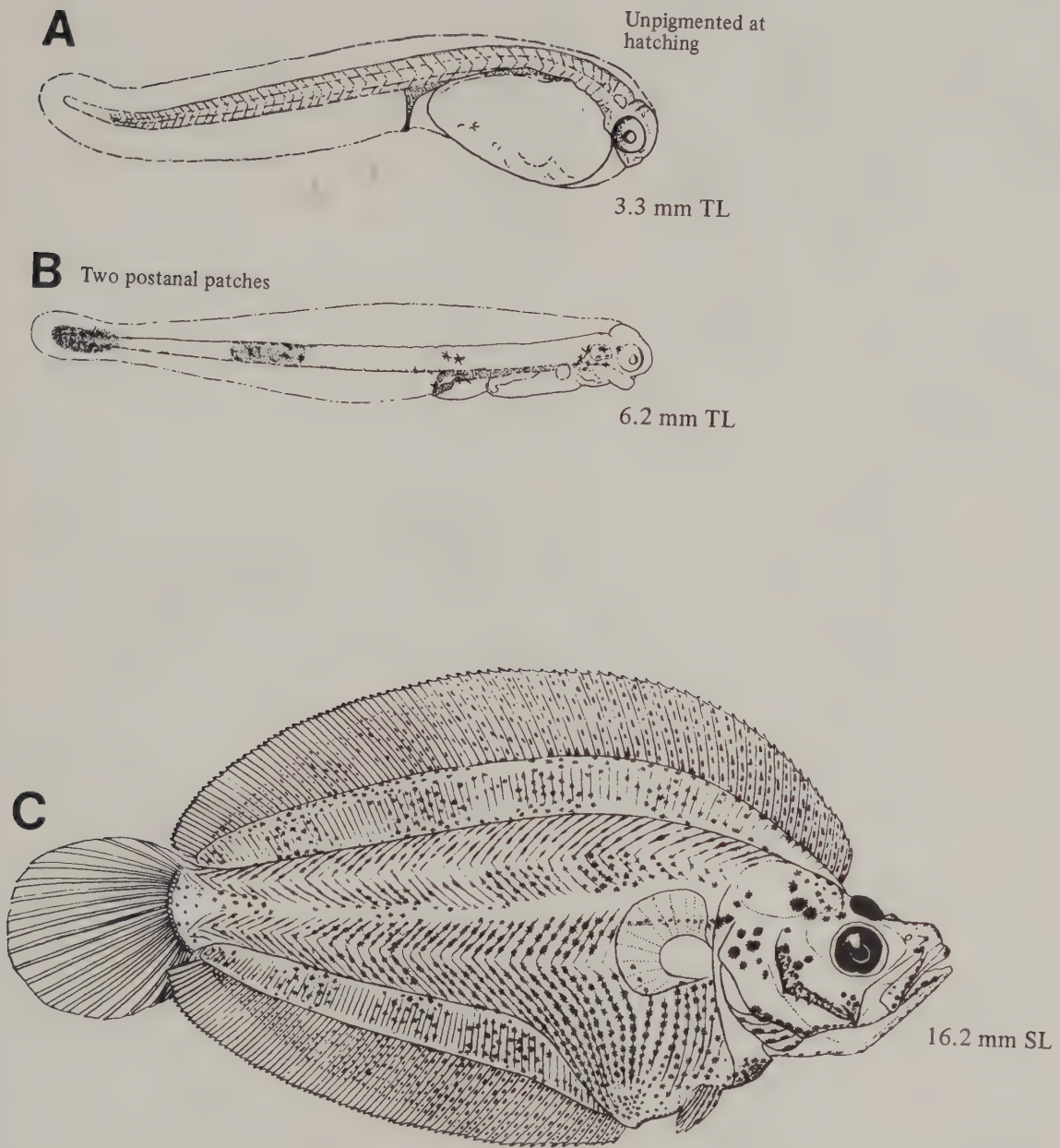
**Diagnostic characters**

Distinguished from other pleuronectids by

- Presence of two postanal pigment bands including pigment on urostyle
- Presence of preopercular spines

[a] 15 branched rays.
[b] Alderdice and Forrester 1971
[c] Frey 1971
[d] Forrester 1969
[e] Larvae are rare. Since most routine ichthyoplankton surveys sample only to 200 m, the absence of small larvae in field collections indicates larvae may occur below 200 m.

Ref: Ahlstrom et al. 1984a, Alderdice and Forrester 1971.




Figures A–B, Alderdice and Forrester 1971; C, Ahlstrom et al. 1984a.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 52-X-60 |
| | Precaudal: 9-9-9 |
| | Caudal: 43-43-43 |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | |
| **Pelvic fin** | Thoracic |
| | R: 6-6-6 |
| **Dorsal fin** | R: 83-X-97 |
| **Pectoral fin** | R: 10-X-12 |
| **Anal fin** | R: 72-X-80 |
| **Gill rakers** | U: X-X-X L: 7-X-10 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Bering Sea, 54-66°N |
| **Ecology** | Epi- and mesobenthal |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.20-1.61 mm |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous |
| **Envelope** | Thick, sometimes striated |
| **Hatch size** | 4.1-5.2 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |
| • Yolksac | |
| • Late-stage embryo | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | 15-17 mm SL |
| **Length at transformation** | 50-60 mm SL;[a] eye migration begins at 35 mm SL |
| **Sequence of fin development** | Caudal, dorsal and anal, pelvics, pectorals |
| **Pigment** | |
| • Finfold (dorsal and anal) | |
| • Three postanal bands | |

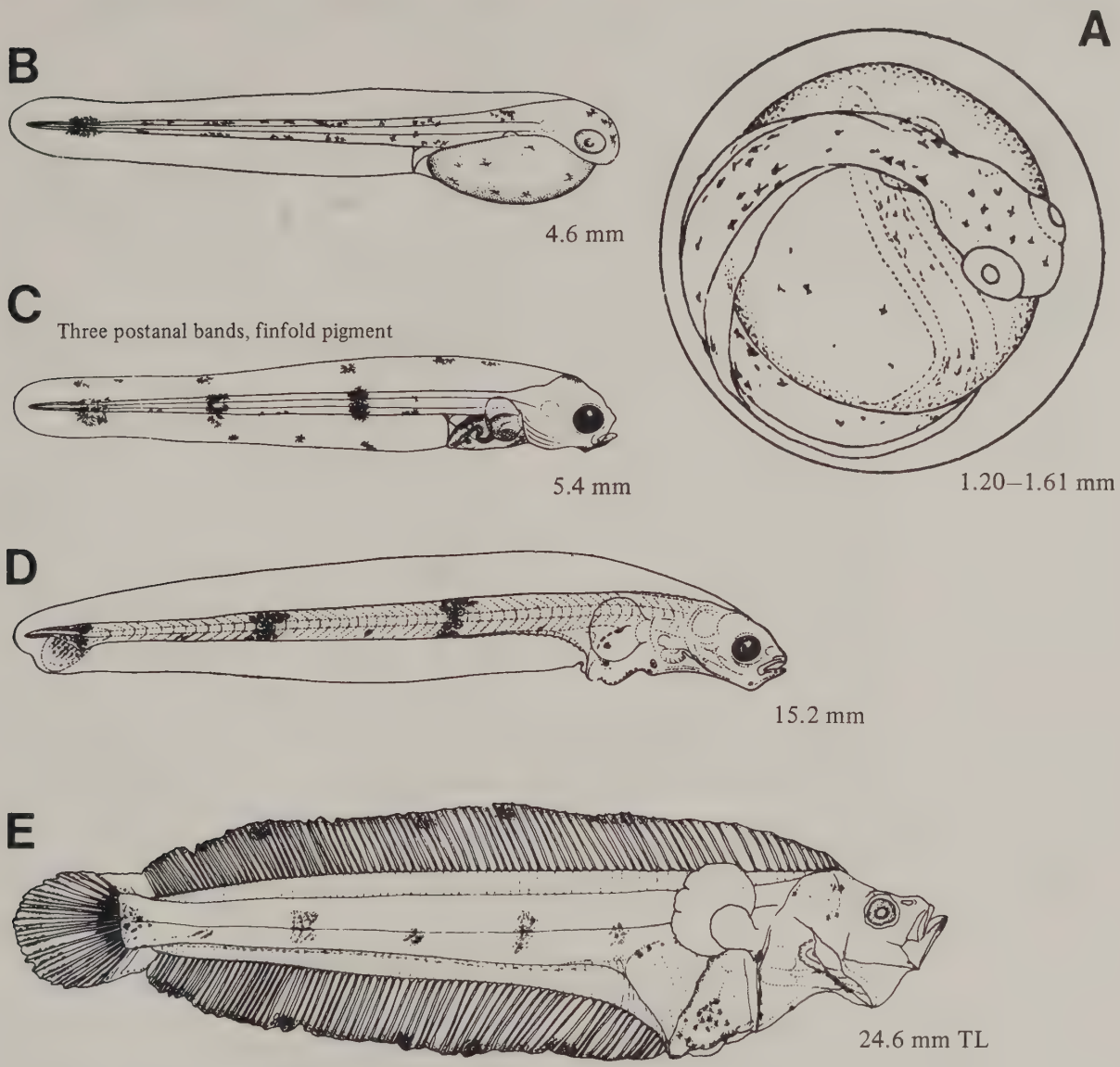
**Diagnostic characters**

Distinguished from other pleuronectids by
- Presence of three postanal pigment bands
- High myomere count (52-60)
- Presence of preopercular spines

Distinguished from *G. zachirus* by
- Fewer myomeres (52-60)
- Pigment pattern
  - —Presence of finfold pigment
  - —Difference in band pattern (fewer bands)

[a] Ahlstrom et al. 1984a: 19-48 mm SL.

Ref: Ahlstrom et al. 1984a, Okiyama 1963, Okiyama and Takahashi 1976, Pertseva-Ostroumova 1961.




Figures A–D, Pertseva-Ostroumova 1961 (B–C, reversed); E, Okiyama and Takahashi 1976.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 63-64-66 |
| | Precaudal: 12-13-14 |
| | Caudal: 50-51-52 |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | 4, 8+7, 4 |
| | Total rays=22-23[a] |
| **Pelvic fin** | Thoracic |
| | R: 6-6-6 |
| **Dorsal fin** | R: 87-102-110 |
| **Pectoral fin** | R: 11-X-13 |
| **Anal fin** | R: 78-85-93 |
| **Gill rakers** | U: 4-4-4 L: 5-X-8 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Bering Sea, 54-66°N |
| **Ecology** | Epi-, meso-, and bathybenthal, 0-850 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Jan-June[b] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: 3900-238,000/ $F=0.00000053797\times L^{4.22667}$, L=TL mm[b] |
| **Age at first maturity** | 5-9 yr (females)[b] |
| | 3-5 yr (males)[b] |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.80-2.2 mm |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous |
| **Envelope** | Surface may be irregular or appear bumpy |
| **Hatch size** | ~5 mm SL |
| **Incubation time/temp.** | |

**Pigment**

- Pigment on yolksac
- Late stage (three bands + caudal)

**Diagnostic characters**

Distinguished from *Lyopsetta exilis* (p. 606) and *Microstomus pacificus* (p. 608) by

- Size
- Pigment on yolksac, late-stage embryo
- Wide perivitelline space
- Size of embryo (coiling in *G. zachirus*)

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | 15.3-24.0 mm SL |
| **Length at transformation** | 49-59 mm SL[c] |
| **Sequence of fin development** | Caudal, dorsal and anal, pelvics, pectorals |

**Pigment**

- Postanal body
  - —Three bands
  - —Caudal band (above, below, and in finfold)
  - —Melanophores between bands
- Head, lower jaw, gut
- With development, caudal pigment becomes restricted to hypural area

**Diagnostic characters**

- See *G. stelleri* (p. 584)

Distinguished from other pleuronectids by

- Presence of four postanal pigment bands
- High myomere count (63-66)
- Presence of preopercular spines

See *Embassichthys bathybius* (p. 580) and *Microstomus pacificus* (p. 608) for similar larvae

[a] 13 branched rays.
[b] Hosie and Horton 1977
[c] According to Ahlstrom et al. (1984a), transformation may occur as late as 72 mm SL.

Ref: Ahlstrom and Moser 1975, Ahlstrom et al. 1984a.

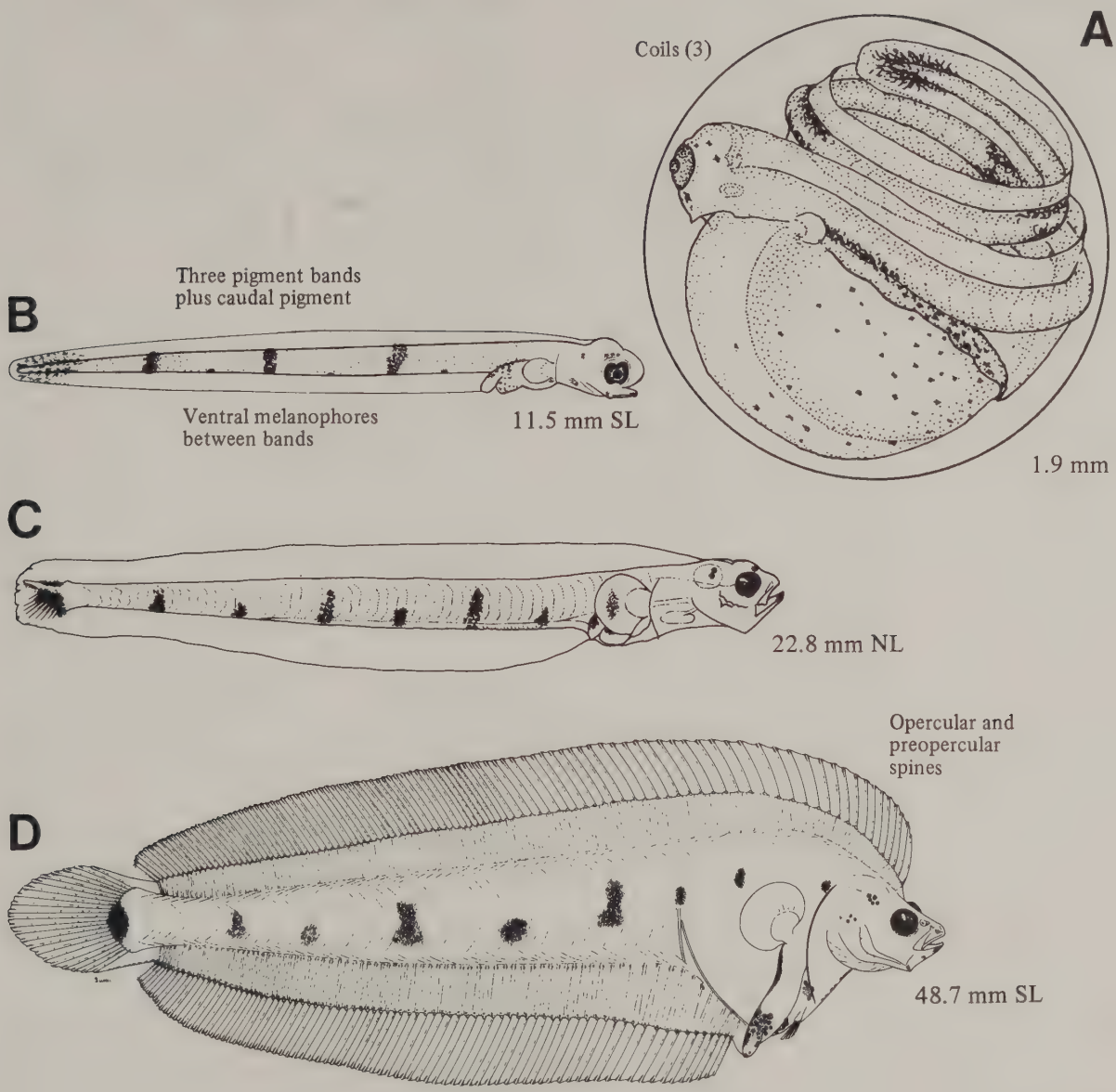



Figure A, Ahlstrom and Moser 1980; B, NWAFC original (B. Vinter); C–D, Ahlstrom et al. 1984a (after Ahlstrom and Moser 1975).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 43-44-47 |
| | Precaudal: 12-13-13 |
| | Caudal: 32-X-35 |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | X, 7+7, X |
| | Total rays=18[a] |
| **Pelvic fin** | Thoracic |
| | R: 6-6-6 |
| **Dorsal fin** | R: 72-79-90 |
| **Pectoral fin** | R: 10-X-12 |
| **Anal fin** | R: 55-62-71 |
| **Gill rakers** | U: X-X-X L: 14-20-26 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Cent. California, 34-38°N, to Bering Sea, 54-66°N |
| **Ecology** | Epi-, meso-, and bathybenthal, 0-875 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Feb-July[b] |
| | Area: 50-305 m[b] |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: 70,000-600,000[c] |
| **Age at first maturity** | 1-2 yr[c] |
| **Longevity** | 21 yr[b] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 2.75-3.75 mm (2.9-3.5 mm) |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous, colorless |
| **Envelope** | Smooth |
| **Hatch size** | 5.3-6.9 mm SL[d] |
| **Incubation time/temp.** | |

**Pigment**

- Yolksac
- Late-stage embryo: On body and in dorsal and ventral finfold

**Diagnostic characters**

- Wide perivitelline space
- Body and finfold pigment

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | 9-10 mm SL |
| **Length at transformation** | Probably gradual, beginning between 18 and 21 mm SL |
| **Sequence of fin development** | Caudal, dorsal, and anal; pelvics; pectorals |

**Pigment**

- Three postanal bands and along ventral midline
- Around urostyle
- Finfold
- With development becoming less pigmented

**Diagnostic characters**

Distinguished from other pleuronectids with three postanal pigment bands by

- Presence of hypaxial, fin, and urostyle pigment
- Low myomere count (43-47)

[a] 12 branched rays.
[b] Salveson 1976
[c] Miller 1969
[d] Pertseva-Ostroumova 1961

Ref: Ahlstrom et al. 1984a, Pertseva-Ostroumova 1961.

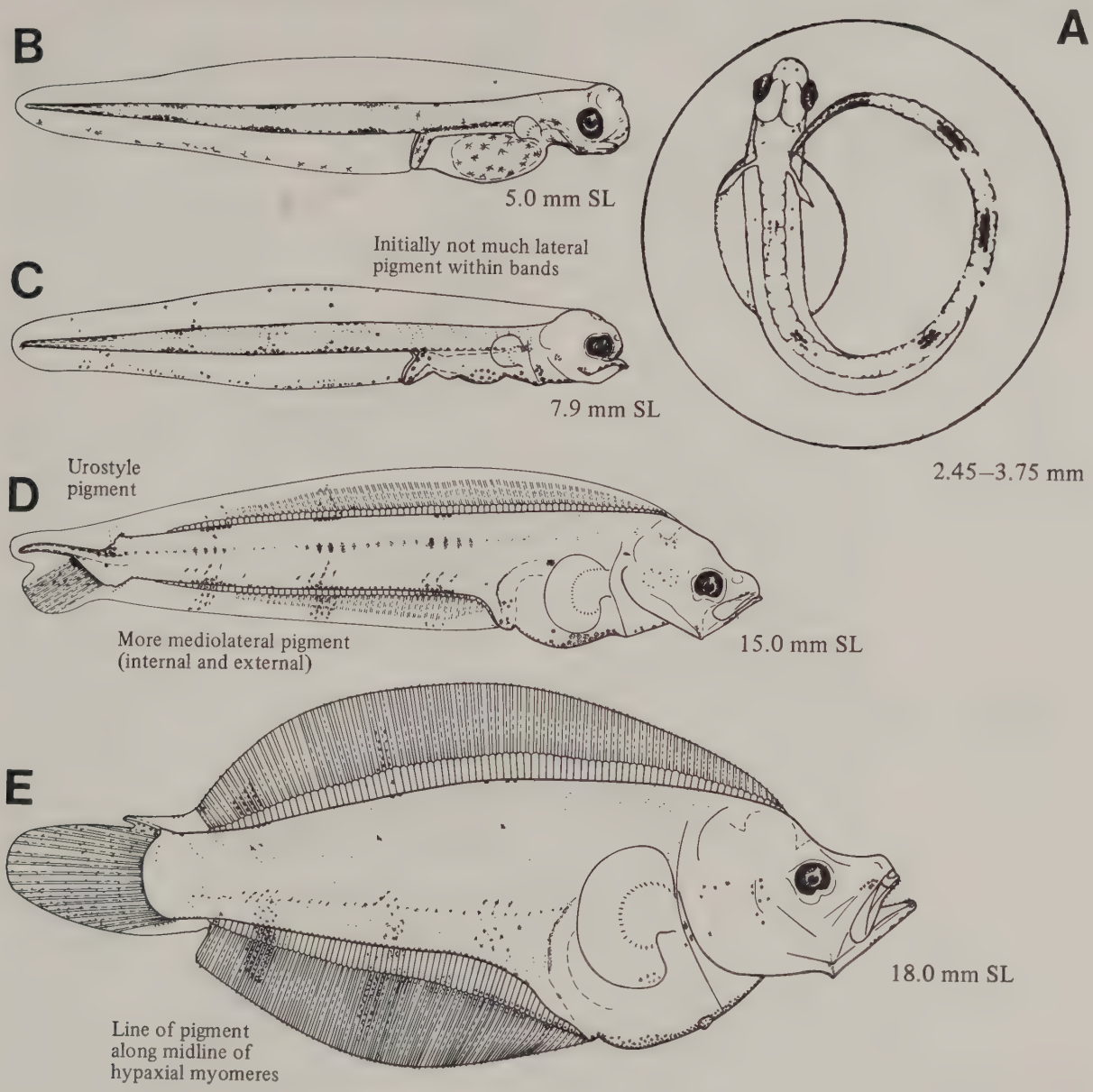



Figure A, Pertseva-Ostroumova 1961; B–E, NWAFC originals (B. Vinter).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 44-44-44 |
| | Precaudal: 12-12-12 |
| | Caudal: 32-32-32 |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | |
| **Pelvic fin** | Thoracic |
| | R: 6-6-6 |
| **Dorsal fin** | R: 66-74-80 |
| **Pectoral fin** | R: 10-10-10 |
| **Anal fin** | R: 53-59-64 |
| **Gill rakers** | U: 1-1-1 L: 10-12-17 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Aleutian Is., 51-55°N, to Chukchi Sea, north of 66°N |
| **Ecology** | Epi- and mesobenthal, 18-425 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Apr-June[a] |
| | Area: Shallow gulfs and bays (50-150 m)[a] |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 2.04-2.69 mm; occasionally up to 2.90 mm |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | Smooth, thin |
| **Hatch size** | 4 mm SL |
| **Incubation time/temp.** | |

**Pigment**

- Yolksac
- Late-stage embryo: On body

**Diagnostic characters**

- Wide perivitelline space
- Smaller in diameter than *H. elassodon*

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | ~11 mm SL |
| **Length at transformation** | >28.6 mm SL[b] |
| **Sequence of fin development** | |

**Pigment**

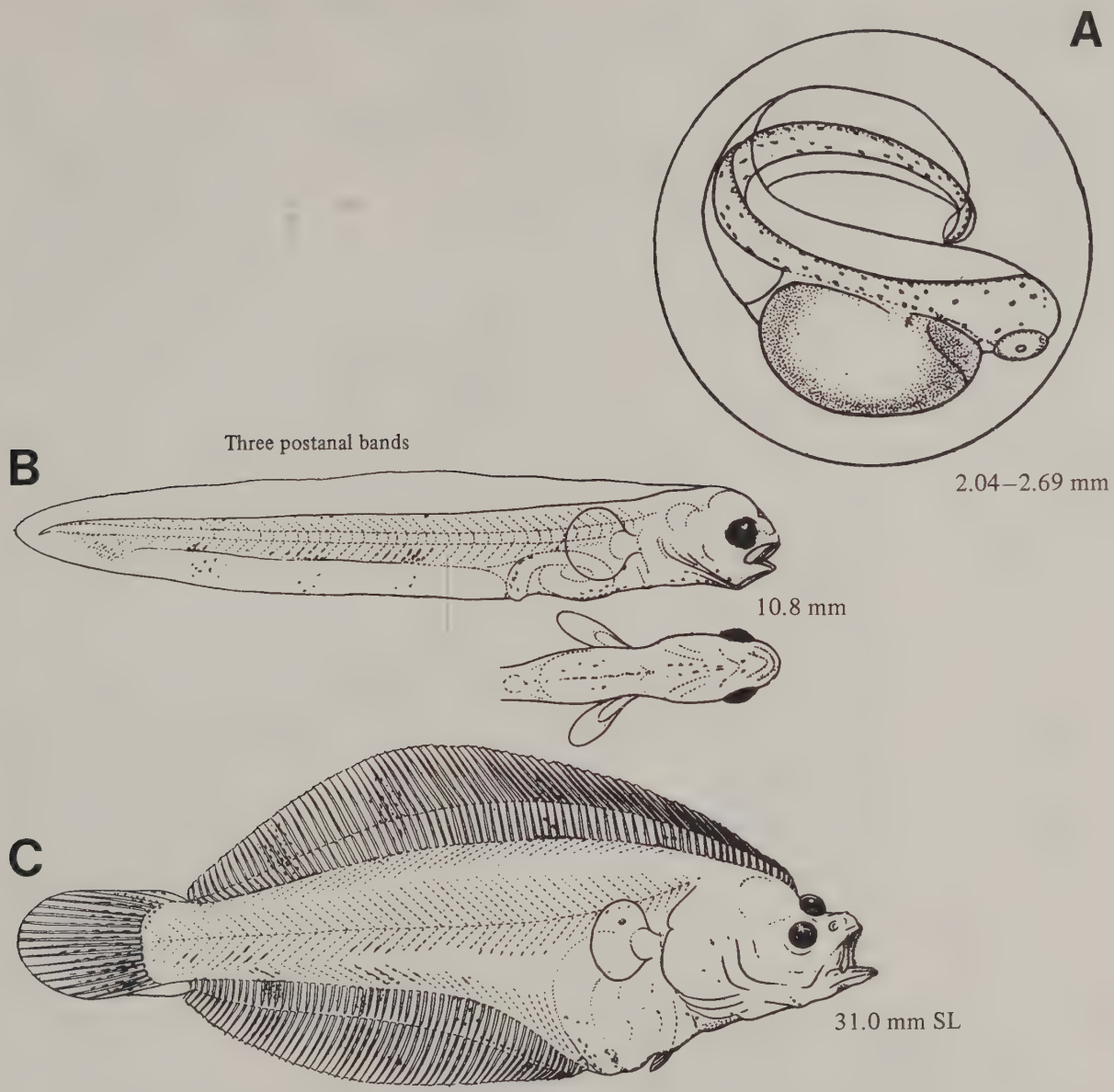
- Three postanal bands extending into finfold

**Diagnostic characters**

- See *H. elassodon* (p. 588)

[a] Pertseva-Ostroumova 1961
[b] Ahlstrom et al. 1984a

Ref: Ahlstrom et al. 1984a, Pertseva-Ostroumova 1961.




Figures A–C (B insert, ventral view of head), Pertseva-Ostroumova 1961.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 49-50-51<br>Precaudal: 16-16-16<br>Caudal: 35-35-35 |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | Total rays=19 |
| **Pelvic fin** | Thoracic<br>R: 6-6-6 |
| **Dorsal fin** | R: 89-99-109 |
| **Pectoral fin** | R: 19-19-19 |
| **Anal fin** | R: 64-75-81 |
| **Gill rakers** | U: X-X-X L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Chukchi Sea, north of 66°N |
| **Ecology** | Epi-, meso-, and bathybenthal, 6-1110 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Nov-Mar[a]<br>Area: 180-550 m[a]<br>Mode:<br>Migration: To deepwater spawning banks in Gulf of Alaska[b] |
| **Fecundity** | Range/function: 200,000-4 million[c] |
| **Age at first maturity** | 7-20 yr (females)[a]<br>5-20 yr (males)[a] |
| **Longevity** | 42 yr (females)[d]<br>27 yr (males)[d] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 2.9-3.8 mm |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous, dense, yellow (after preservation) |
| **Envelope** | Shallow honeycomb pattern (not always visible on preserved specimens but slight surface irregularities are easily discernible) |
| **Hatch size** | 7.8-8.5 mm SL |
| **Incubation time/temp.** | |

**Pigment**

- Embryo unpigmented at hatching

**Diagnostic characters**

- Large size (>3.0 mm)
- Lack of pigment

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | 13.6-17.8 mm SL |
| **Length at transformation** | 14.7-24.1 mm SL[e] |
| **Sequence of fin development** | Caudal, dorsal and anal, pelvics, pectorals |

**Pigment**

- Lack of pigment in yolksac larvae
- Series of melanophores along dorsal surface of notochord and along ventral midline
- Median finfolds pigmented along edge

**Diagnostic characters**

Distinguished from other pleuronectids by

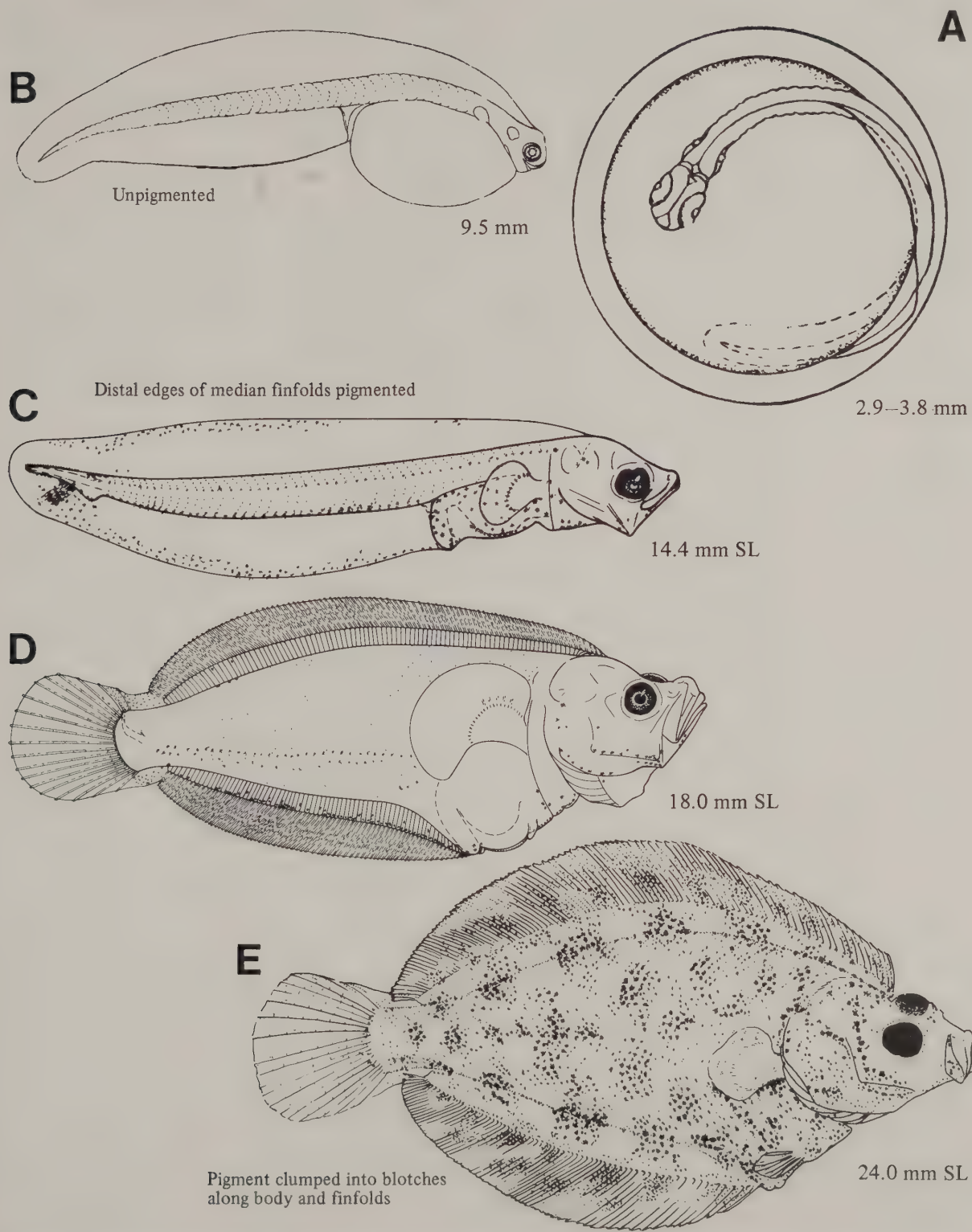
- Myomeres (49-51)
- Pigment: Lack of bands, and presence of pigment on ventral midline and along edges of median finfolds

Distinguished from *Reinhardtius hippoglossoides* (both have large yolksac larvae) by

- See *R. hippoglossoides* (p. 622)

[a] St. Pierre 1984
[b] Thompson and Van Cleve 1936
[c] Schmitt and Skud 1978
[d] Webber and Alton 1976
[e] Become juveniles at 28 mm SL.

Ref: Ahlstrom et al. 1984a, Pertseva-Ostroumova 1961, Thompson and Van Cleve 1936.




Figures A–B, Pertseva-Ostroumova 1961 (after Thompson and Van Cleve 1939); C–D, NWAFC originals (B. Vinter); E, Ahlstrom et al. 1984a.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 41-42-42 |
| | Precaudal: 10-10-11 |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 7-X-8 |
| **Caudal fin** | X, 7+6, X |
| | Total rays = 18[a] |
| **Pelvic fin** | Thoracic |
| | R: 6-6-6 |
| **Dorsal fin** | R: 78-86-90 |
| **Pectoral fin** | R: 11-X-13 |
| **Anal fin** | R: 58-66-69 |
| **Gill rakers** | U: X-X-X L: 7-X-8 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Bering Sea, 54-66°N |
| **Ecology** | Epi- and mesobenthal, 20-425 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Feb-Apr[b] |
| | Area: Coastal waters[b] |
| | Mode: Schools[b] |
| | Migration: |
| **Fecundity** | Range/function: 350,000-650,000[c] |
| **Age at first maturity** | 3 yr (females)[b] |
| | 2 yr (males)[b] |
| **Longevity** | 11 yr (females)[d] |
| | 10 yr (males)[d] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 0.84-1.00 mm; occasionally up to 1.10 mm |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous |
| **Envelope** | Striated |
| **Hatch size** | 2.7-2.9 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

Very difficult to distinguish from the three other 1.0-mm pleuronectid eggs in the area:

*Parophrys vetulus* (p. 610)
*Platichthys stellatus* (p. 612)
*Psettichthys melanostictus* (p. 620)

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | 9-10 to 14 mm SL |
| **Length at transformation** | 15->21 mm SL |
| **Sequence of fin development** | Caudal, dorsal, and anal; pelvics; pectorals |

**Pigment**

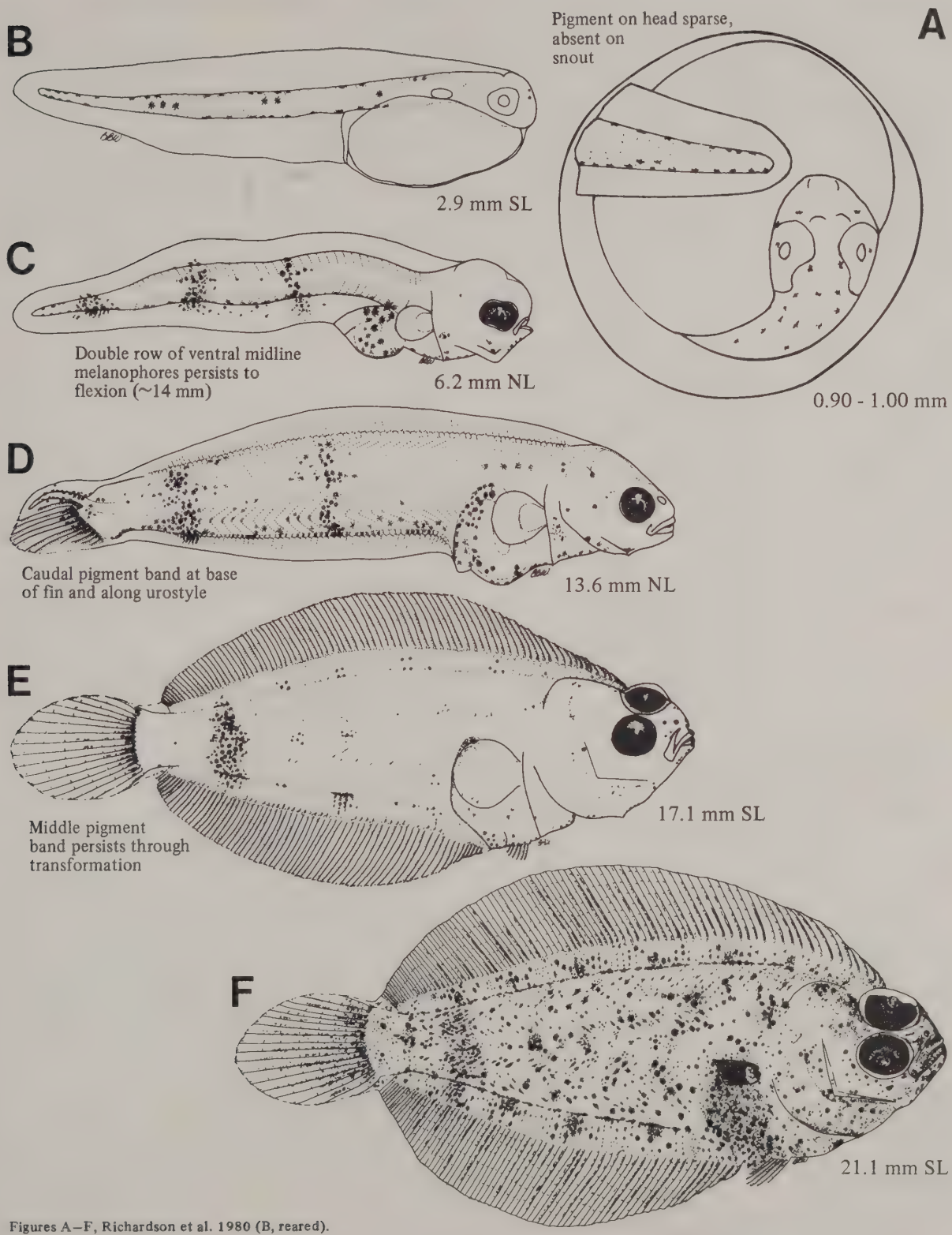
- Three postanal bands at 50, 67, 90% SL
- Melanophores extend ventrally on gut and along posterior portion of abdominal cavity

**Diagnostic characters**

- Three pigment bands
- Low myomere count (41-42)

[a] 11 branched rays.
[b] Smith 1936
[c] Forrester 1969
[d] Hart 1973

Ref: Richardson et al. 1980.




Figures A–F, Richardson et al. 1980 (B, reared).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 39-40-42<br>Precaudal: 10-11-12<br>Caudal: 28-30-31 |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | Total rays=18-19[a] |
| **Pelvic fin** | Thoracic<br>R: 6-6-6 |
| **Dorsal fin** | R: 65-76-84 |
| **Pectoral fin** | R: 8-11-13 |
| **Anal fin** | R: 50-58-65 |
| **Gill rakers** | U: 3-3-3 L: 5-X-8 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Bering Sea, 54-66°N |
| **Ecology** | Epi-, meso-, and bathybenthal, 0-579 m |
| **ELH pattern** | Oviparous; demersal, adhesive eggs; pelagic larvae |
| **Spawning** | Season: Feb-Apr[b]<br>Area:<br>Mode:<br>Migration: |
| **Fecundity** | Range/function: 400,000-1,300,000 (Brit. Col.);[c] 150,000-400,000 (Bering Sea);[d] 80,000-920,000 (western Pacific)/ $F=0.0004891\times L^{3.720}$, L=BL cm[e] |
| **Age at first maturity** | 3-4 yr (females)[b]<br>2 yr (males)[b] |
| **Longevity** | 15 yr (females)[f]<br>22 yr (males)[f] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 0.87-1.00 mm; 1.02-1.09 mm[g] |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous |
| **Envelope** | Thick, elastic, bright yellow or orange |
| **Hatch size** | 5 mm SL; 3.6-4.0 mm SL;[g] 3.4-3.8 mm SL[h] |
| **Incubation time/temp.** | 9-12 d/6.5-8.0°C |
| **Pigment** | |

**Diagnostic characters**

- Demersal egg

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | 8.4-9.9 mm SL |
| **Length at transformation** | ~20 mm SL; >17.7 mm SL[h] |
| **Sequence of fin development** | Caudal, dorsal, and anal; pelvics; pectorals |

**Pigment**

- Dorsally on peritoneum, ventrolateral gut pigment becoming posterolateral with development
- Postanal ventral melanophores ~3/4 length of body
- Two dorsolateral patches, the posterior one becoming a band meeting the ventral surface
- Anal finfold lightly pigmented on posterior half

**Diagnostic characters**

Distinguished from other pleuronectids by

- Presence of one band posteriorly on body, not as conspicuous as most
- Size at transformation (20 mm SL)
- Advanced stage of development at hatching

See *Lepidopsetta* 2 (p. 599) and *Psettichthys melanostictus* (p. 620)

[a] 12 branched rays.
[b] Smith 1936
[c] Forrester 1969
[d] Fadeev 1965
[e] Shvetsov 1979
[f] Hart 1973
[g] Pertseva-Ostroumova 1961
[h] Ahlstrom et al. 1984a

Ref: Ahlstrom et al. 1984a, Forrester 1964, Pertseva-Ostroumova 1961.

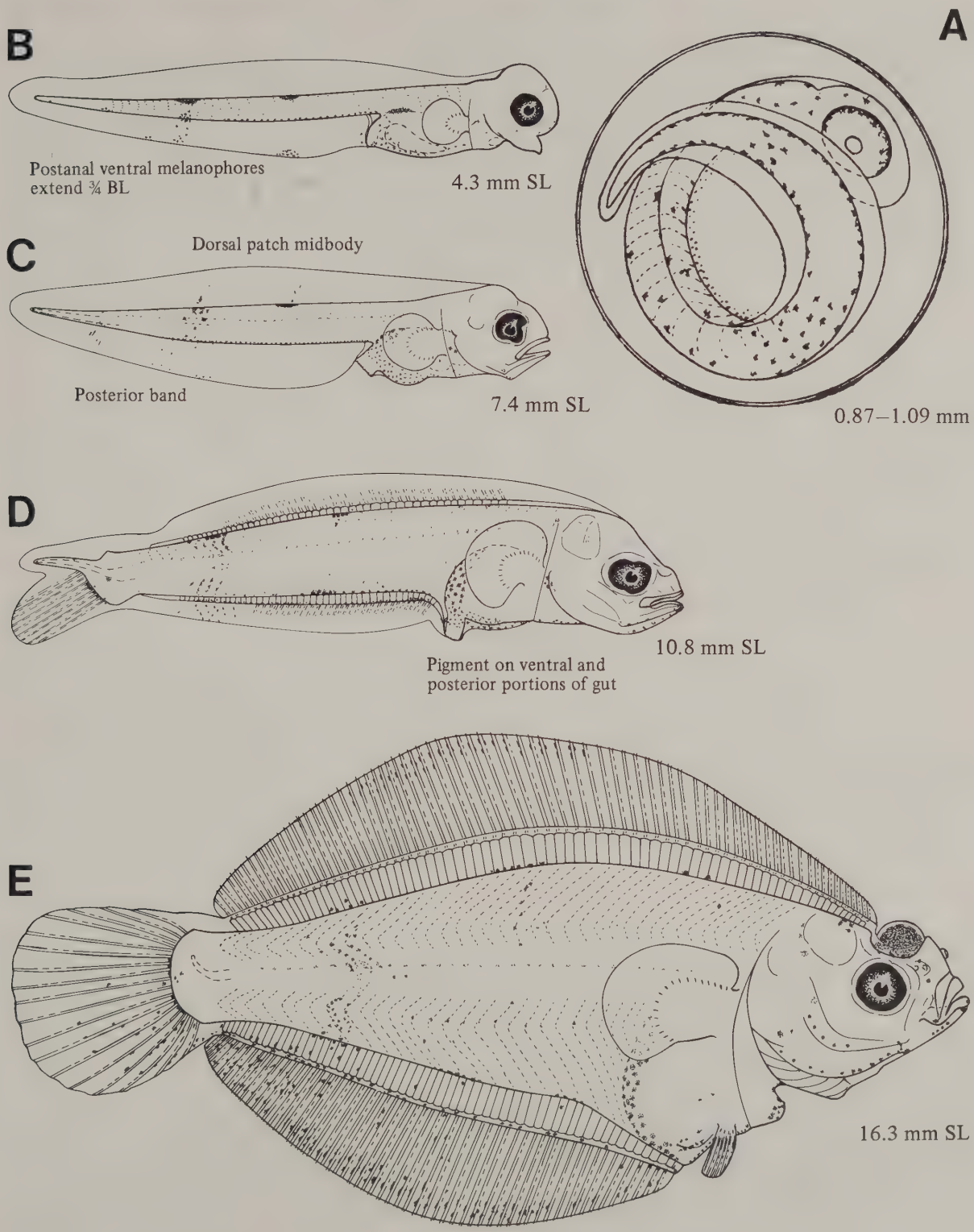



Figure A, Pertseva-Ostroumova 1961; B–E, NWAFC originals (B. Vinter).

## *Lepidopsetta bilineata/Lepidopsetta* 2/*Psettichthys melanostictus*

Two readily distinguishable types of *Lepidopsetta* larvae are collected in our study area which we designate *Lepidopsetta bilineata* and *Lepidopsetta* 2. Wilimovsky et al. (1967) had previously indicated that there are two subspecies of *Lepidopsetta* in the Northeast Pacific based on adult specimens (*L. b. bilineata* and *L. b. peracuata*). *Lepidopsetta* 2 larvae are very similar to larvae of *Psettichthys melanostictus* at certain stages of development. We present *Lepidopsetta* 2 as a separate series, since these larvae are distinct from those of *L. bilineata* and *P. melanostictus*. The following pigment patterns and morphological characters separate the three kinds of larvae.

***Psettichthys melanostictus*** (see also p. 620)

Range from California to Alaska, but the center of distribution appears to be off California, Oregon, and Washington.

Pigment

- Postanal ventral midline melanophores: Usually restricted to 3-4 large spots
- Tail pigment less prominent than on *Lepidopsetta* 2
- Pigment on upper and lower jaw
- Isthmus pigment heavier than on others
- First spot along dorsal midline more anterior (over anus)

Morphology

- Gut coiled, shape of posterior gut
- Deeper body (wider finfold)

***Lepidopsetta* 2** (see p. 600, 601)

Range from Puget Sound to Alaska, and center of distribution appears to be off Southeast Alaska and in the Gulf of Alaska.

Pigment

- Postanal ventral midline melanophores: A series of small melanophores extending from the gut to the last myomere; sometimes a larger spot occurs about midbody (with larvae 6.3-9.7 mm SL, there may be more spots than at other sizes)
- First spot along dorsal midline behind anus
- Other: Tail pigment more intense, but mouth and isthmus pigment less intense than on *Psettichthys*

Morphology

- Eye relatively larger than on *Psettichthys* at similar ontogenetic stages
- Gut shape simple

***Lepidopsetta bilineata*** (see also p. 596)

Range from southern California to the Bering Sea.

Pigment

- Postanal ventral midline melanophores: A series of small melanophores extending from the gut to about 2/3 body
- Only two spots along dorsal midline; anterior spot at midbody, posterior spot forming a band at about myomere 30
- No heavy pigment along edges of median finfold
- Tail pigment less prominent than on others
- Pigment along hypural edge

Morphology

- Gut shape simple

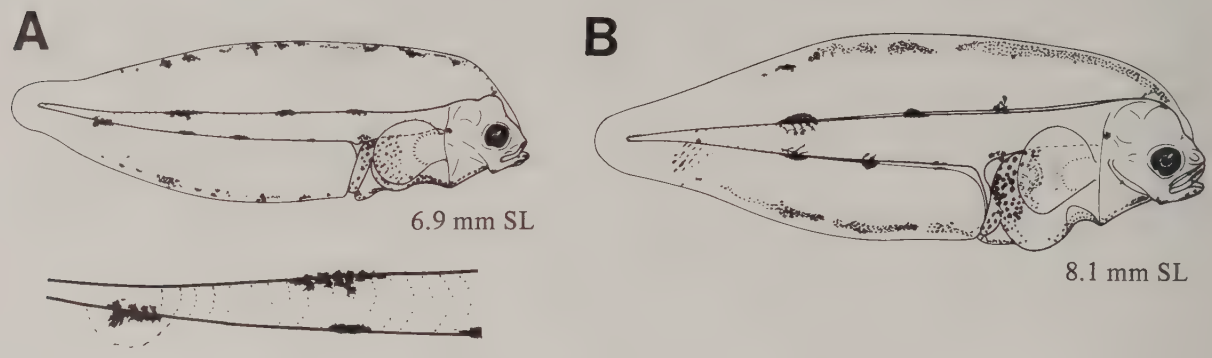
Finfold pigment may or may not be an additional criterion for separating *Lepidopsetta* 2 and *Psettichthys*. Many *Psettichthys* specimens in our collection appear to have more prominent finfold pigment that is retained longer during development; however, many of these are laboratory-reared specimens. More wild-caught *Psettichthys* specimens are needed to verify whether they all have intense finfold pigment.

Yolksac larvae are more difficult to separate. *Psettichthys* larvae appear to possess upper and lower jaw pigment, smaller, more concentrated melanophores in the finfold and on the urostyle, and the last postanal band has a ventral stripe only. *Lepidopsetta* 2 yolksac larvae appear to have only lower jaw pigment, larger, fewer, and evenly spaced melanophores in the finfold and urostyle, and the last postanal band has a dorsal and ventral stripe.

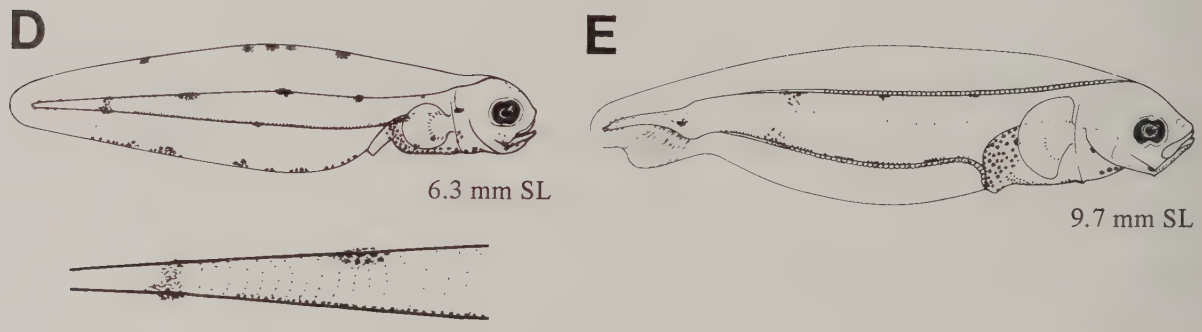
Literature: Specimens illustrated by Ahlstrom et al. (1984a) are both *Psettichthys* based primarily on the presence of the coiled gut and the 2-3 large ventral melanophores (Fig. 351C, p. 662, and Fig. 352E, p. 663). Hickman (1959) illustrated six *Psettichthys* larvae from specimens he reared from eggs (his Figs. 1 and 2) and from specimens he collected in Puget Sound (his Figs. 3-6). Hickman's Figures 3 and 4 appear to resemble *Lepidopsetta* 2 larvae, while his other figures appear to resemble *Psettichthys*.

## *PSETTICHTHYS / LEPIDOPSETTA*

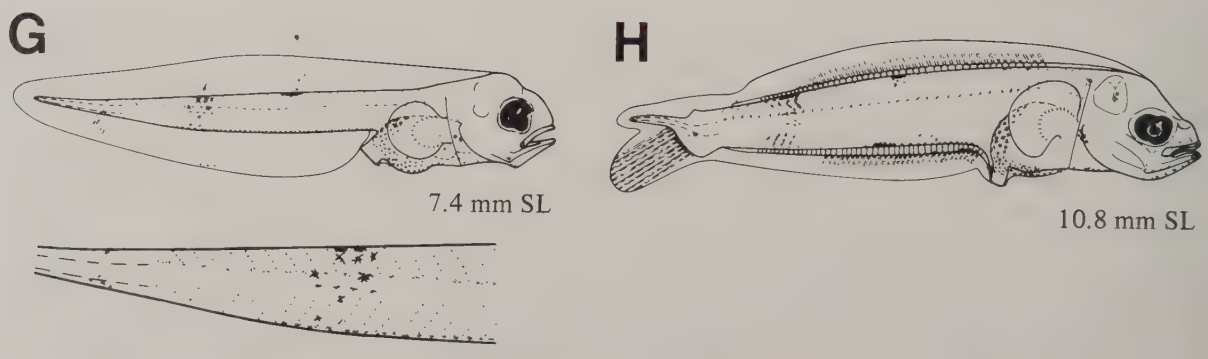
*Psettichthys melanostictus*




*Lepidopsetta* 2



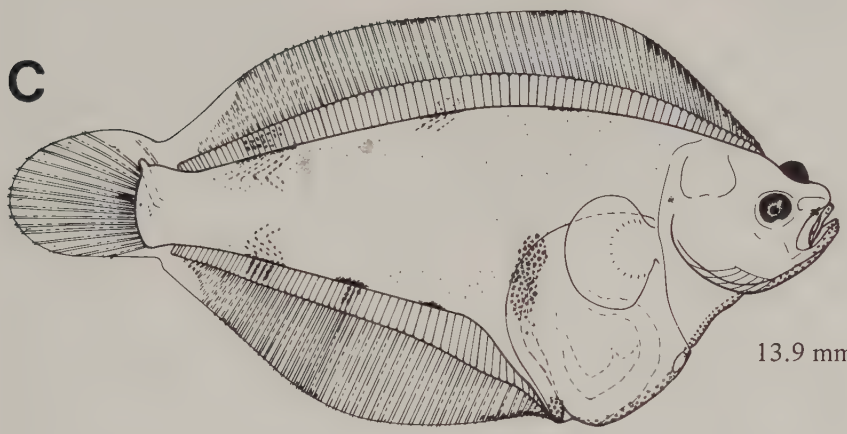

*Lepidopsetta bilineata*




Figures A–I, NWAFC originals (B. Vinter; A, D, G, include a detailed enlargement of tail).

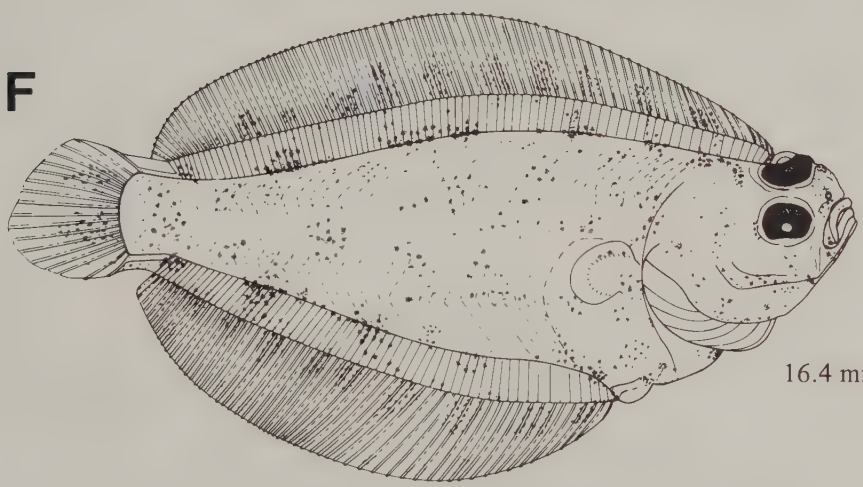
***PSETTICHTHYS / LEPIDOPSETTA***

C



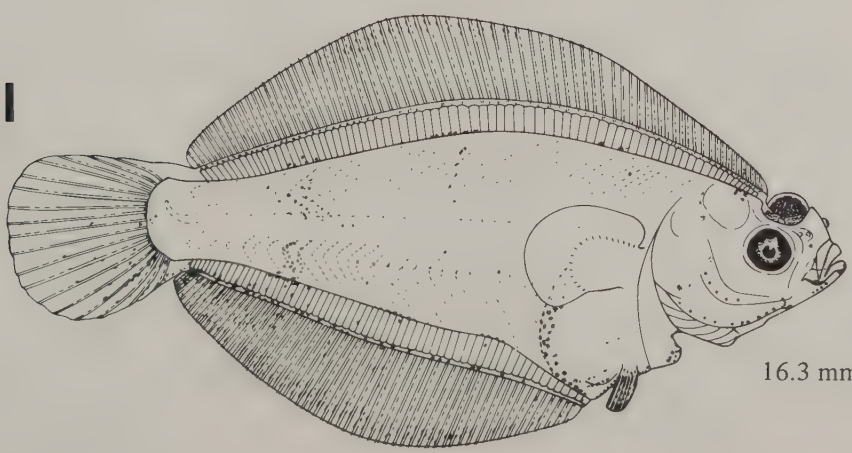
13.9 mm SL

F



16.4 mm SL

I



16.3 mm SL

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 40-40-41 |
| | Precaudal: 10-X-12 |
| | Caudal: 28-X-30 |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | Total rays=18[a] |
| **Pelvic fin** | Thoracic |
| | R: 6-6-6 |
| **Dorsal fin** | R: 61-69-77 |
| **Pectoral fin** | R: 10-X-12 |
| **Anal fin** | R: 49-52-58 |
| **Gill rakers** | U: X-X-X L: 8-X-10 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Brit. Col., 48°30′-55°N, to Chukchi Sea, north of 66°N |
| **Ecology** | Epi-, meso-, and bathybenthal, 10-600 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Summer[b] |
| | Area: Inner shelf region[b] |
| | Mode: Mass[b] |
| | Migration: To shallower water of shelf[b] |
| **Fecundity** | Range/function: 1,300,000-3,300,000/ $F=0.0747565\times L^{2.86517}$ (F in 1000 eggs), L=TL cm[b] |
| **Age at first maturity** | 6-7 yr (females)[b] |
| | 4-5 yr (males)[b] |
| **Longevity** | 19 yr (females)[b] |
| | 17 yr (males)[b] |

[a] 12 branched rays.
[b] Salveson and Alton 1976b
[c] Ahlstrom et al. 1984a
[d] According to Allen and Smith (1988), this species occurs in the Bering Sea.
[e] Pertseva-Ostroumova 1961

Ref: Ahlstrom et al. 1984a, Pertseva-Ostroumova 1961, Schmidt 1950.

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 0.76-0.85 mm |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous, yellowish |
| **Envelope** | Clear, smooth |
| **Hatch size** | 2.25-2.80 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**
- Size

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | ~7 mm SL; 7.5-9.5 mm SL[c] |
| **Length at transformation** | 15-17 mm SL; may begin at 10 mm SL[c] |
| **Sequence of fin development** | Caudal, dorsal and anal, pelvics, pectorals |

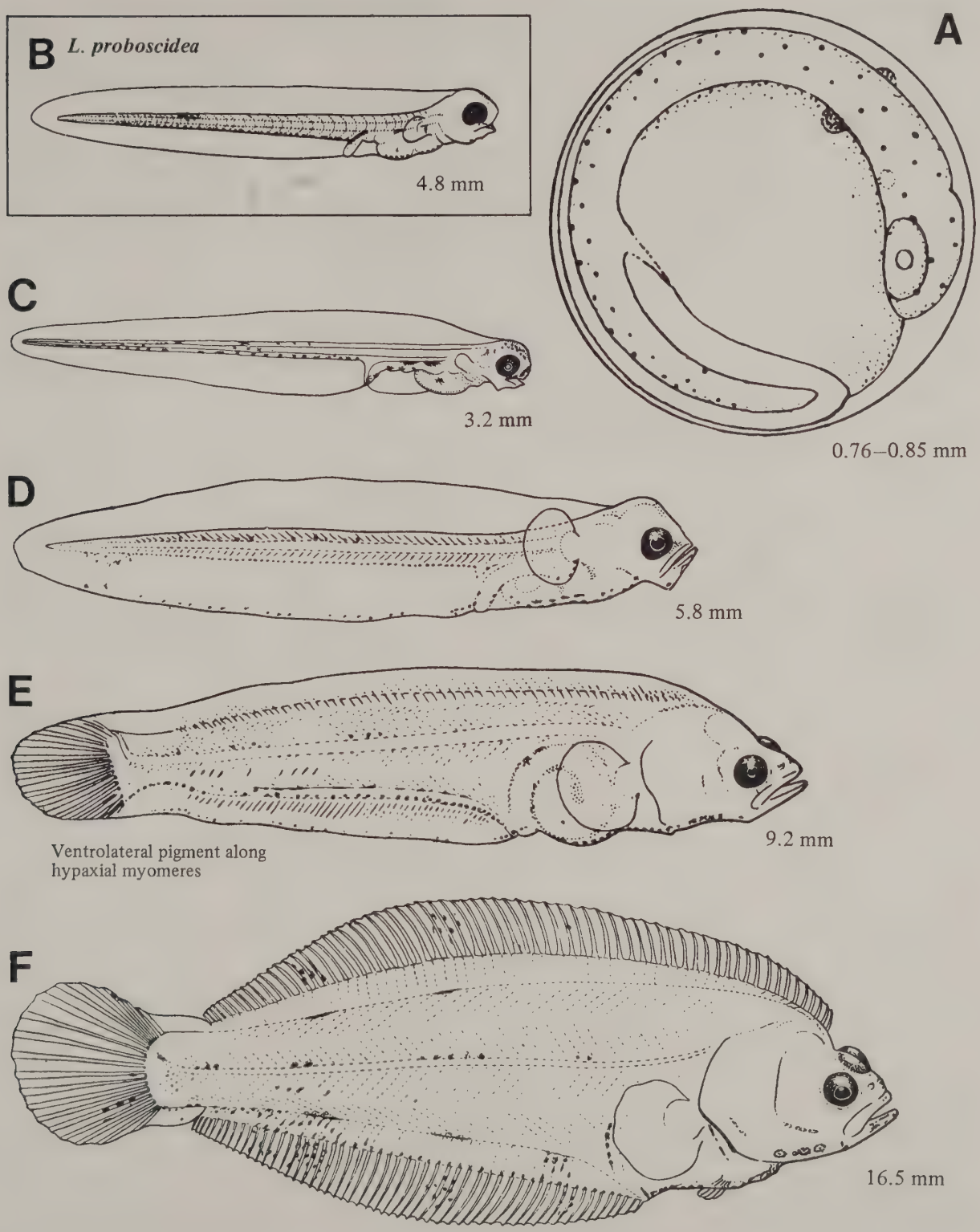
**Pigment**
- Mediolateral, along notochord
- Ventrolateral, along hypaxial myomeres
- Anal finfold

**Diagnostic characters**

Distinguished from other pleuronectids without postanal pigment bands by
- Ventrolateral pigment along hypaxial myomeres
- Size at transformation (15-17 mm SL)
- Finfold pigment restricted to anal fin
- Urostyle unpigmented

*L. proboscidea* and *L. sakhalinensis*[d] eggs and larvae are incompletely known. The following information may aid in identification.

| | *L. proboscidea* | *L. sakhalinensis* |
|---|---|---|
| Egg diameter | 0.72-0.87 mm | |
| Total vertebrae | 38-40 | |
| Precaudal | 11 | |
| Caudal | 27-29 | |
| Dorsal fin rays | 62-69 | 68-76 |
| Pectoral fin rays | 12 | |
| Anal fin rays | 46-50 | 53-59 |
| Range | Bering Sea-Chukchi Sea | |
| Spawning season | Spring-summer[e] | |




Figures A–F (C, reversed), Pertseva-Ostroumova 1961.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 37-X-41 |
| | Precaudal: 11-X-13 |
| | Caudal: 26-26-26 |
| **Branchiostegal rays** | 7-X-8 |
| **Caudal fin** | Total rays=18 |
| **Pelvic fin** | Thoracic |
| | R: 6-6-6 |
| **Dorsal fin** | R: 48-X-64 |
| **Pectoral fin** | R: 8-X-12 |
| **Anal fin** | R: 33-X-46 |
| **Gill rakers** | U: 2-X-4 L: 7-X-8 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Bering Sea, 54-66°N, to Arctic, not specific |
| **Ecology** | Nearshore shelf demersal |
| **ELH pattern** | Oviparous, demersal eggs, pelagic larvae |
| **Spawning** | Season: Jan-Mar[a] |
| | Area: Shallow water, 5-10 m[a] |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: 31,000-230,000[a] |
| **Age at first maturity** | 2+ yr (usually 4-5)[b] |
| **Longevity** | >9 yr[b] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.2-1.7 mm (1.54-1.70 mm) |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | Clear, homogeneous |
| **Envelope** | Thin, smooth |
| **Hatch size** | 3.7 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE[c]

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | |
| **Length at transformation** | |
| **Sequence of fin development** | |

**Pigment**

- Newly hatched larvae heavily pigmented, but with development pigment appears to be restricted to postanal body above and below notochord

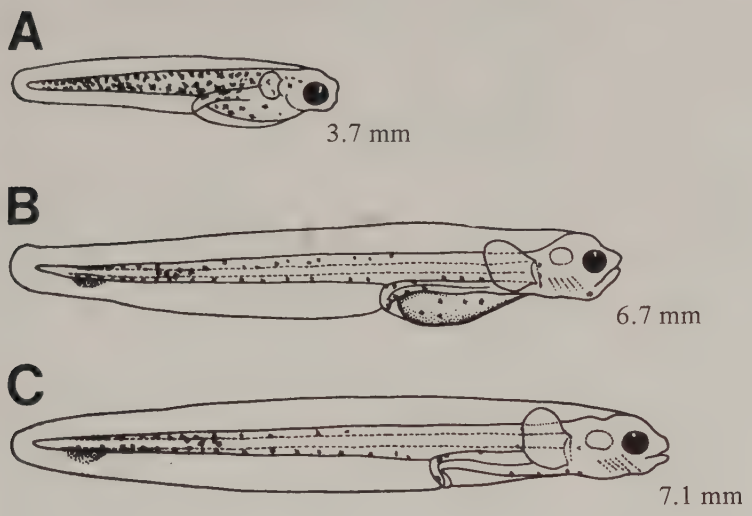
**Diagnostic characters**

Distinguished from other pleuronectids without pigment bands by

- No pigment in finfolds or along hypaxial myomeres
- Myomere count (37-41)

[a] Pertseva-Ostroumova 1961
[b] Andriashev 1954
[c] Preflexion larvae only.

Ref: Pertseva-Ostroumova 1961.




Figures A–C, Pertseva-Ostroumova 1961 (figures reversed).

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 43-45-47 | |
| | Precaudal: 11-12-13 | |
| | Caudal: 32-33-35 | |
| **Branchiostegal rays** | 7-7-7 | |
| **Caudal fin** | X, 8+7, X | |
| | Total rays = 19[a] | |
| **Pelvic fin** | Thoracic | |
| | R: 6-6-6 | |
| **Dorsal fin** | R: 72-77-88 | |
| **Pectoral fin** | R: 10-10-10 | |
| **Anal fin** | R: 57-60-66 | |
| **Gill rakers** | U: 2-X-3 | L: 9-X-11 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Gulf of Alaska, 54-60°N |
| **Ecology** | Epi-, meso-, and bathybenthal, 25-800 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Feb;[b] Apr[c] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | 3-5 yr (females)[c] |
| | 2-3 yr (males)[c] |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.47-1.71 mm |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous |
| **Envelope** | Surface may be irregular and appear bumpy |
| **Hatch size** | ~5.6 mm SL |
| **Incubation time/temp.** | |

**Pigment**

- Yolksac
- Late-stage embryo: Distinct caudal pigment visible

**Diagnostic characters**

- Caudal pigment
- Smallest size range of three similar-looking pleuronectid eggs in the 1.5-2.5 mm size range; see *Glyptocephalus zachirus* (p. 586) and *Microstomus pacificus* (p. 608)

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | 9.0-10.9 mm SL |
| **Length at transformation** | 15.7-24.7 mm SL |
| **Sequence of fin development** | Caudal, dorsal and anal, pelvics, pectorals |

**Pigment**

- Early and midflexion larvae
  - —Dorsal and ventral midline melanophores around tail and in finfold; with development, these melanophores move laterally on body along myoseptal lines
  - —Finfold pigment increases to cover anal finfold and posterior half of dorsal finfold
- Gut pigment increases ventrally with development

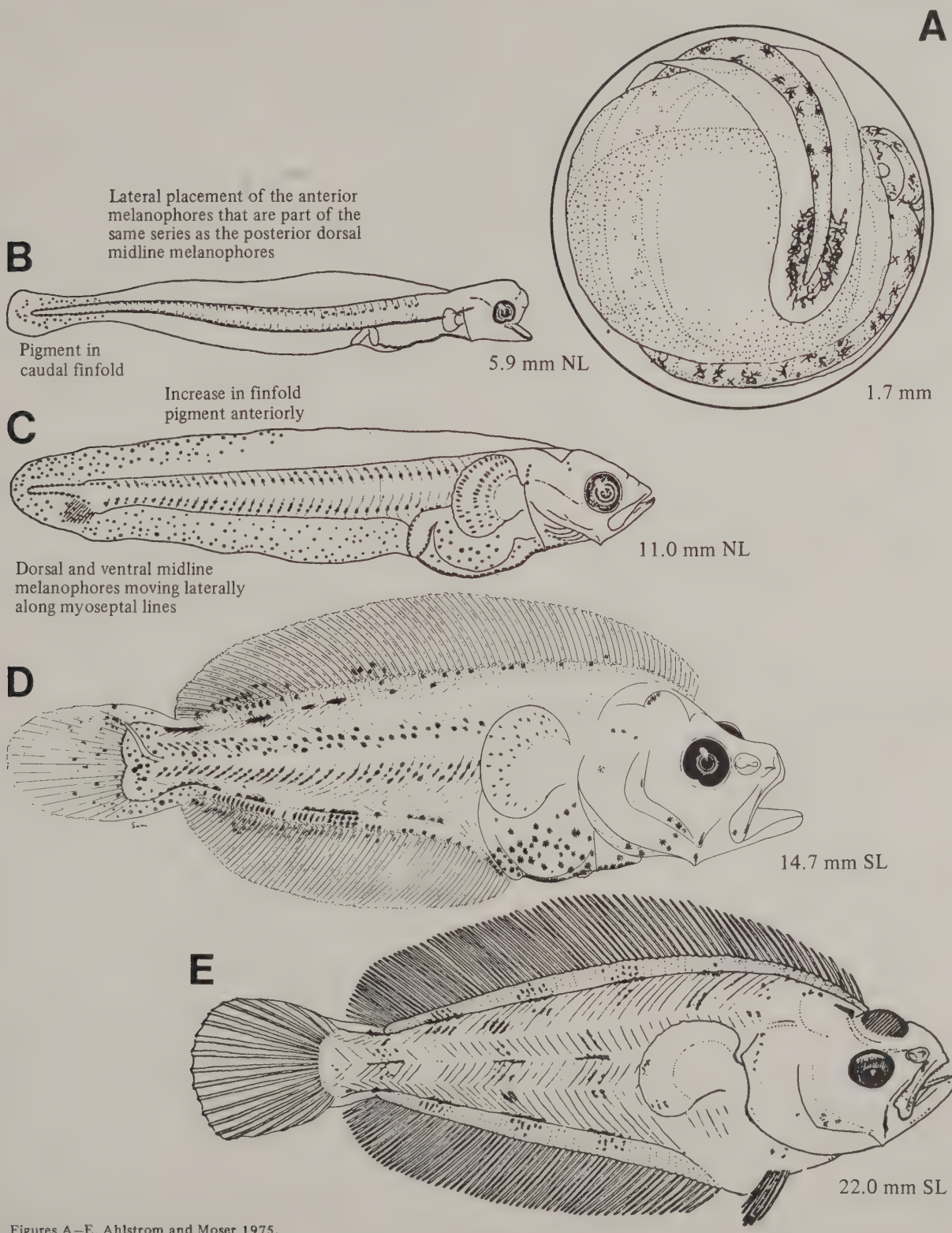
**Diagnostic characters**

Distinguished from other pleuronectids without pigment bands by

- Pigment pattern: Continuous dorsal and ventral midline
- In preflexion larvae, the anterior melanophores of the dorsal midline series extend laterally
- Finfold pigment

[a] 12-13 branched rays.
[b] Hart 1973
[c] Smith 1936

Ref: Ahlstrom and Moser 1975, Ahlstrom et al. 1984a.


A
1.7 mm
B
Lateral placement of the anterior melanophores that are part of the same series as the posterior dorsal midline melanophores
Pigment in caudal finfold
5.9 mm NL
C
Increase in finfold pigment anteriorly
Dorsal and ventral midline melanophores moving laterally along myoseptal lines
11.0 mm NL
D
14.7 mm SL
E
22.0 mm SL

Figures A–E, Ahlstrom and Moser 1975.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 50-52-55 |
| | Precaudal: 11-12-13 |
| | Caudal: 38-40-41 |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | X, 9+8, X |
| | Total rays=21[a] |
| **Pelvic fin** | Thoracic |
| | R: 6-6-6 |
| **Dorsal fin** | R: 94-105-116 |
| **Pectoral fin** | R: 8-X-12 |
| **Anal fin** | R: 80-87-96 |
| **Gill rakers** | U: 5-X-8 L: 8-X-11 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Bering Sea, 54-66°N |
| **Ecology** | Epi-, meso-, and bathybenthal, 9-1189 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Nov-Aug[b] |
| | Area: 80-550 m[b] |
| | Mode: |
| | Migration: Offshore for spawning[c] |
| **Fecundity** | Range/function: 37,188[d]-260,000[e] |
| **Age at first maturity** | 5 yr[f] |
| **Longevity** | 45 yr[g] |

[a] 13-16 branched rays.
[b] Hirschberger and Smith 1983
[c] Westrheim and Morgan 1962
[d] Hagerman 1952
[e] Harry 1959
[f] Frey 1971
[g] Chilton and Beamish 1982

Ref: Ahlstrom and Moser 1975, Ahlstrom et al. 1984a, Richardson 1981b.

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 2.05-2.68 mm |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous |
| **Envelope** | Smooth, slightly thick |
| **Hatch size** | ~6 mm SL |
| **Incubation time/temp.** | 27 d/10°C |

**Pigment**

- Yolksac
- Late-stage embryo: Caudal pigment not as pronounced as *Lyopsetta exilis* (p. 606)

**Diagnostic characters**

- Largest egg of three similar-looking pleuronectid eggs; see *L. exilis* and *Glyptocephalus zachirus* (p. 586)

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | 10-15 mm SL |
| **Length at transformation** | Eye migration begins at 20 mm SL; larvae remain pelagic >45 mm SL |
| **Sequence of fin development** | Caudal, dorsal and anal, pelvics, pectorals |

**Pigment**

- Lower jaw; dorsally and ventrally on gut, with development becoming restricted to ventral surface (isthmus to anus)
- Preflexion
  - —Three pigment patches in addition to tail and finfold
  - —Anterior patch restricted to ventral area; two posterior patches have dorsal and ventral components extending into finfold
  - —Around urostyle and in finfold
- Flexion: Pigment patches occur above notochord and along distal ends of finfold
- Postflexion: Pigment patches along dorsal and anal pterygiophores

**Diagnostic characters**

Distinguished from other pleuronectids with 3-4 pigment bands by

- Pigment bands extending into finfold
- Morphology: Early larvae long and slender, becoming deep-bodied during development
- Otic spines
- Myomeres (50-55)

See also *G. zachirus* (p. 586) and *Hippoglossoides elassodon* (p. 588)

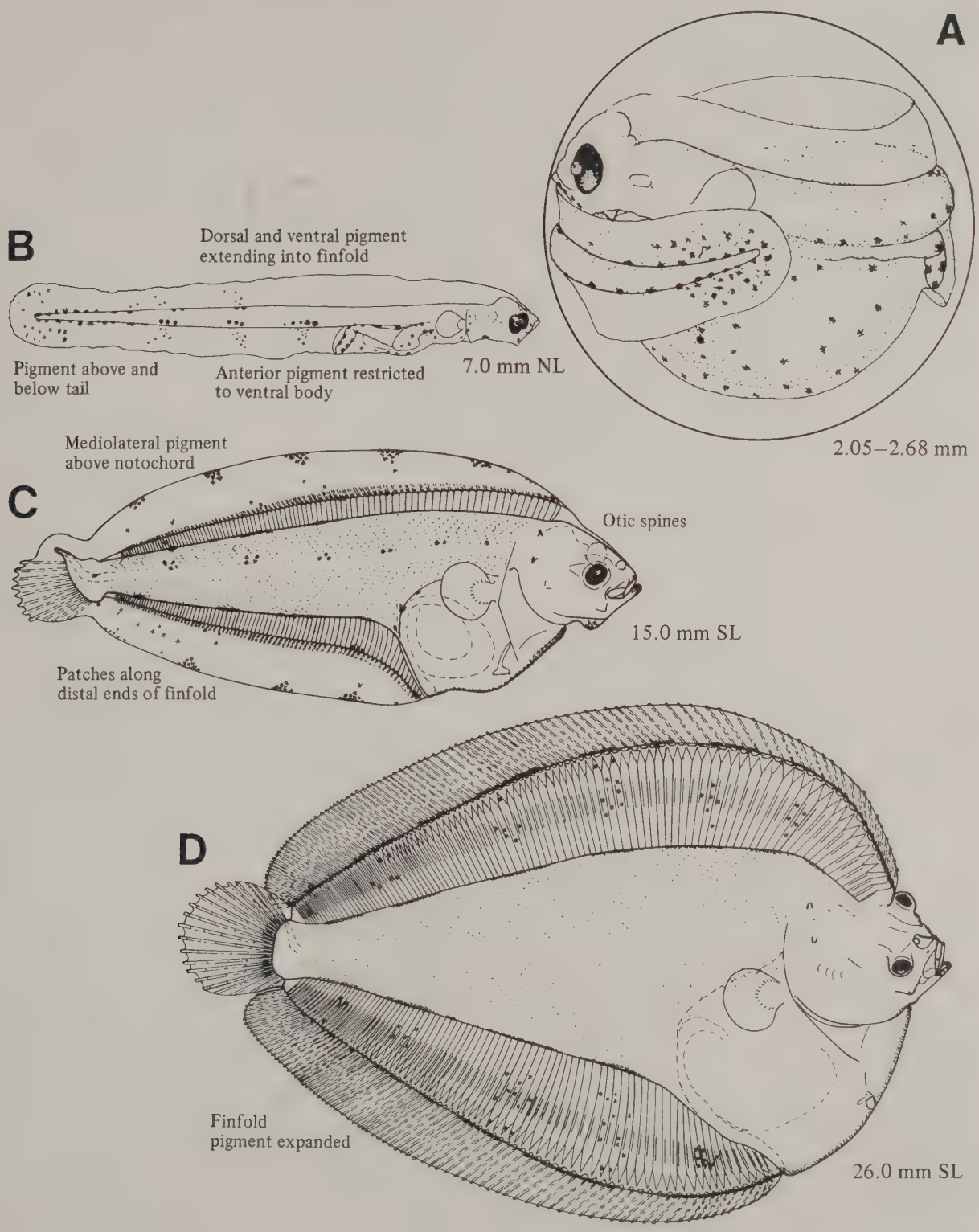



Figure A, Ahlstrom and Moser 1975; B, Ahlstrom et al. 1984a (after Ahlstrom and Moser 1975); C–D, NWAFC originals (B. Vinter).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 42-44-47 |
| | Precaudal: 10-11-12 |
| | Caudal: 31-33-34 |
| **Branchiostegal rays** | 7-X-8 |
| **Caudal fin** | X, 7+7, X |
| | Total rays=18[a] |
| **Pelvic fin** | Thoracic |
| | R: 6-6-6 |
| **Dorsal fin** | R: 72-80-82 |
| **Pectoral fin** | R: 10-X-12 |
| **Anal fin** | R: 54-60-70 |
| **Gill rakers** | U: 4-X-6 L: 10-X-13 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Bering Sea, 54-66°N |
| **Ecology** | Epi-, meso-, and bathybenthal, intertidal to 550 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Oct-May (California);[b] Jan-Apr (Puget Sound)[c] |
| | Area: Demersal[d] |
| | Mode: |
| | Migration: Southern migration from feeding grounds to sheltered water in channels or bights[d] |
| **Fecundity** | Range/function: 150,000-1,950,000[e] |
| **Age at first maturity** | 3-4 yr (females)[c] |
| | 2 yr (males)[c] |
| **Longevity** | 17 yr[f] |

[a] 12 branched rays.
[b] Jow 1969
[c] Smith 1936
[d] Ketchen 1956
[e] Ketchen 1947
[f] Frey 1971
[g] Ahlstrom et al. 1984a

Ref: Budd 1940, Ahlstrom and Moser 1975, Ahlstrom et al. 1984a.

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 0.80-1.05 mm |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous |
| **Envelope** | Thin, smooth, transparent |
| **Hatch size** | 2.3-2.8 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

- See *Isopsetta isolepis* (p. 594)

### LARVAE

| | |
|---|---|
| **Preanal length** | 43-45% SL |
| **Length at flexion** | ~10 mm SL; 8.8-10.5 mm SL[g] |
| **Length at transformation** | Eye migration prior to 17.5 mm SL |
| **Sequence of fin development** | Caudal, dorsal and anal, pelvics, pectorals |

**Pigment**

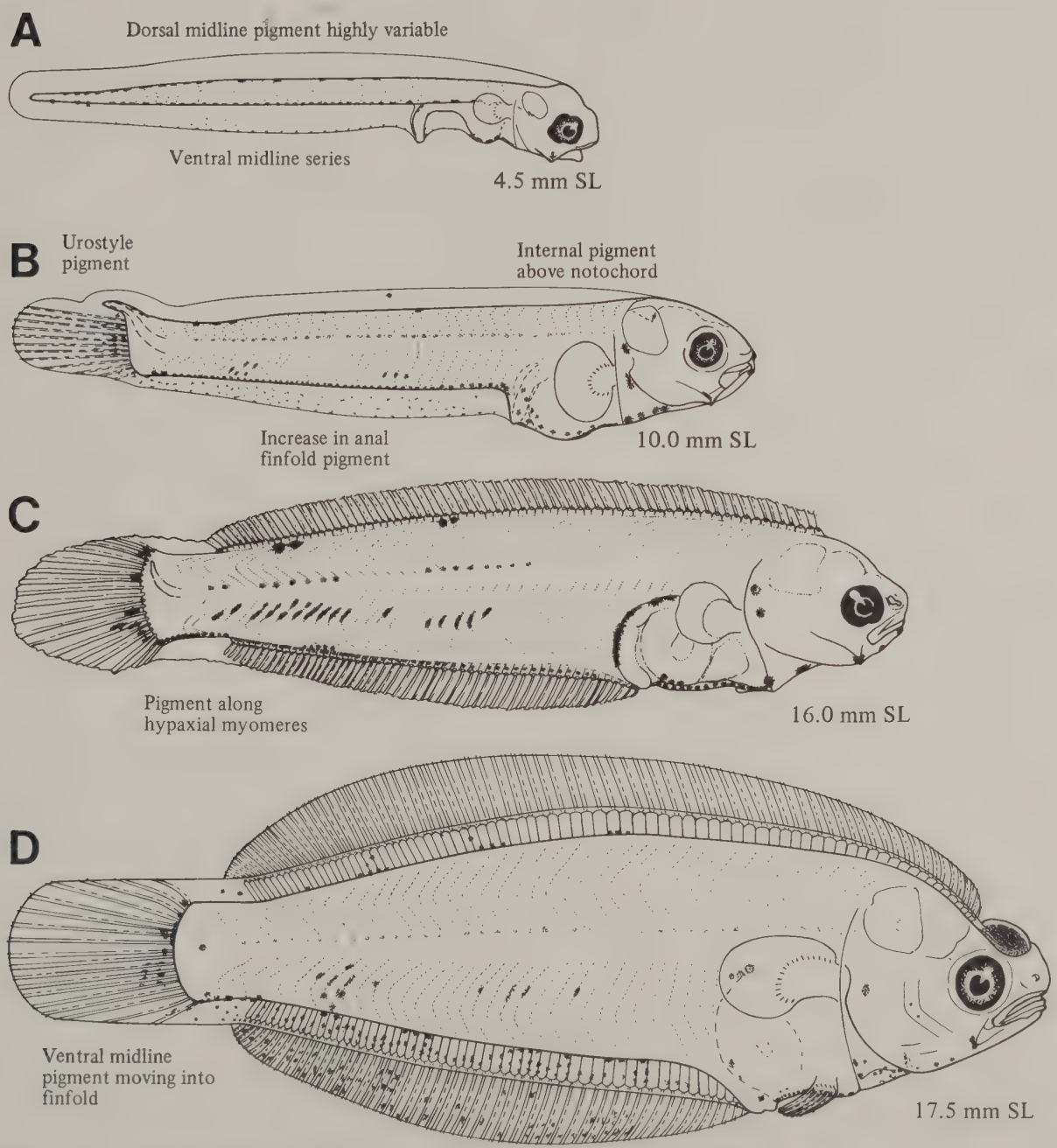
- Initially, anteroventrally on gut; with development, extending posteriorly; in postflexion, a line of pigment forms along the posterior hindgut and anus
- Dorsal and ventral midline: Ventral beginning prior to anus (~ myomere 5) and dorsal at ~ myomere 15 (pigment is variable); dorsal midline becoming less prominent with development as internal pigment develops above notochord through flexion stage
- Myoseptal pigment develops along hypaxial myomeres in postflexion larvae
- Finfold pigment restricted to anal finfold

**Diagnostic characters**

Distinguished from other pleuronectids without pigment bands by

- Dorsal and ventral midline pigment, hypaxial pigment
- Finfold pigment restricted to anal finfold

Note: The number of dorsal midline melanophores in preflexion larvae is highly variable.




Figures A–B, D, NWAFC originals (B. Vinter); C, Ahlstrom et al. 1984a (after Ahlstrom and Moser 1975).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 35-36-38 |
| | Precaudal: 10-11-12 |
| | Caudal: 24-25-26 |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | Total rays=18 |
| **Pelvic fin** | Thoracic |
| | R: 6-6-6 |
| **Dorsal fin** | R: 52-59-66 |
| **Pectoral fin** | R: 9-10-10 |
| **Anal fin** | R: 38-42-47 |
| **Gill rakers** | U: 3-3-3 L: 6-X-8 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Arctic, not specific |
| **Ecology** | Epi- and mesobenthal, freshwater (upstream) to 375 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Nov-Feb (California);[a] Feb-Apr (Puget Sound);[b] May-June (Bering Sea)[c] |
| | Area: Shallow water[a] |
| | Migration: |
| **Fecundity** | Range/function: 900,000[c]-11 million[a] |
| **Age at first maturity** | 3-4 yr (females)[a] |
| **Longevity** | 21 yr[d] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 0.88-1.28 mm |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous |
| **Envelope** | Striated, yellow |
| **Hatch size** | 1.9-2.1 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

- See *Isopsetta isolepis* (p. 594)

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | ~7 mm SL; 5.5-6.0 mm SL[e] |
| **Length at transformation** | 10.5 mm SL (may be slightly smaller, 8-9 mm SL) |
| **Sequence of fin development** | Caudal, dorsal and anal, pelvics, pectorals |

**Pigment**

- Lightly scattered over head and posteroventrally along gut
- Initially, in preflexion larvae, postanal pigment scattered along anal finfold and along posterior 1/3 of body
- Around urostyle
- Internally above notochord, becoming less concentrated with development
- Pigment in dorsal fin disappears with development
- Postflexion larvae lightly pigmented with lateral patches

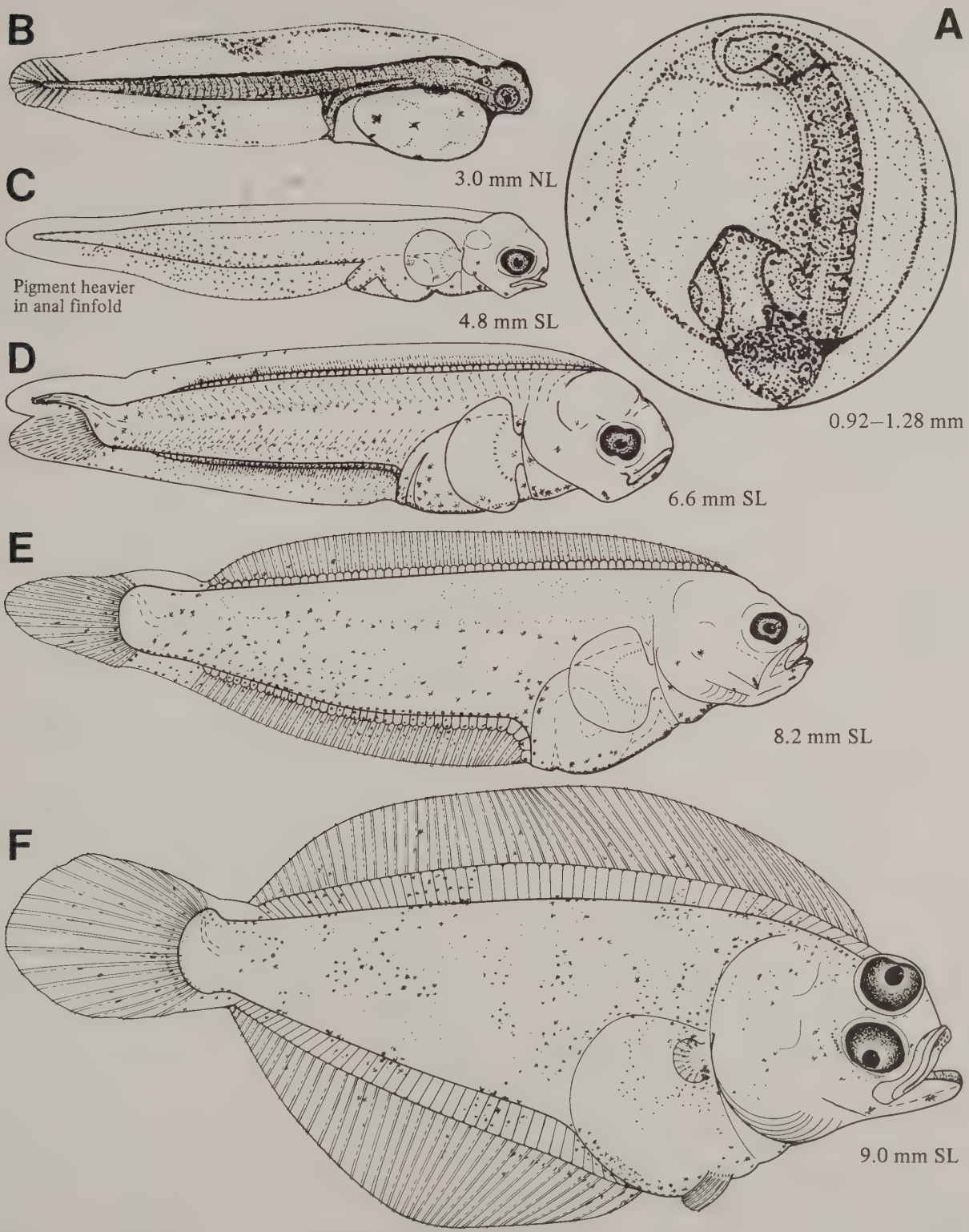
**Diagnostic characters**

Distinguished from other pleuronectids without pigment bands by

- Lack of dorsal midline pigment
- Small size at transformation (<10 mm SL)

[a] Orcutt 1950
[b] Hart 1973
[c] Fadeev 1965
[d] Wolotira et al. 1977
[e] Ahlstrom et al. 1984a

Ref: Ahlstrom et al. 1984a, Orcutt 1950, Pertseva-Ostroumova 1961, Yusa 1957.




Figures A–B, Orcutt 1950 (B, reversed); C–F, NWAFC originals (B. Vinter).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 41-X-42 |
| | Precaudal: 18-18-19 |
| | Caudal: X-X-X |
| **Branchiostegal rays** | 7-X-8 |
| **Caudal fin** | |
| **Pelvic fin** | Thoracic |
| | R: 6-6-6 |
| **Dorsal fin** | R: 62-69-71 |
| **Pectoral fin** | R: 11-11-11 |
| **Anal fin** | R: 51-51-56 |
| **Gill rakers** | U: X-X-X L: 7-7-7 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | Gulf of Alaska, 54-60°N, to Chukchi Sea, north of 66°N |
| **Ecology** | Epi- and mesobenthal, 6-475 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Spring[a] |
| | Area: |
| | Mode: |
| | Migration: Inshore[a] |
| **Fecundity** | Range/function: |
| **Age at first maturity** | 4 yr[a] |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.67-2.21 mm (1.7-1.9 mm) |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | Thick wavy surface (color: bronze hue) |
| **Hatch size** | ~5.85 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | ~8-10 mm SL |
| **Length at transformation** | Beginning by 10.7 mm SL |
| **Sequence of fin development** | Caudal, dorsal and anal, pelvics, pectorals |

**Pigment**

- Isthmus, posteroventrally on gut
- Initially, in preflexion larvae, dorsal spots over posterior half of body that become less prominent with development
- Ventral midline melanophores extend onto finfold and on caudal region
- Internal row above notochord throughout development

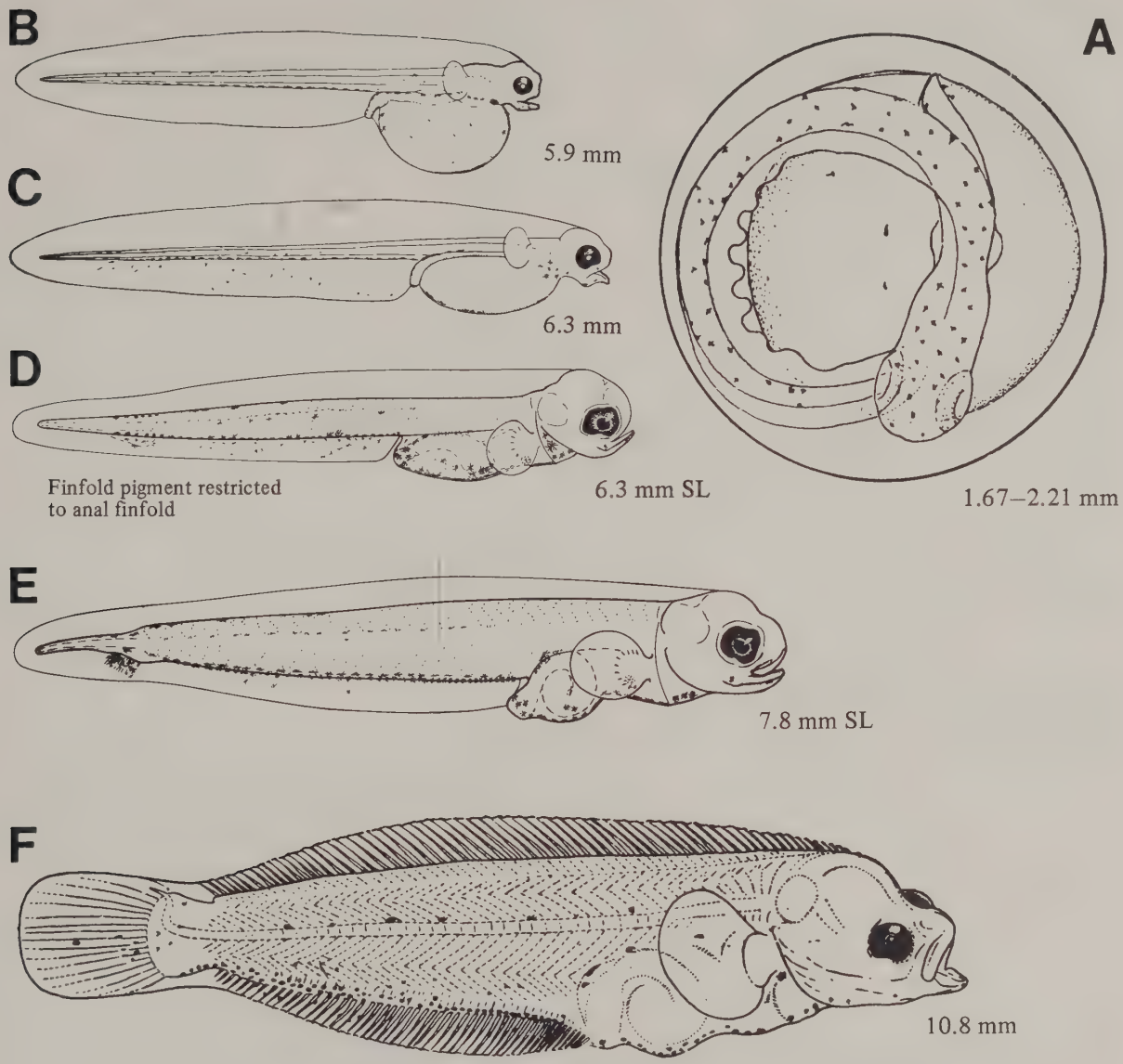
**Diagnostic characters**

Distinguished from other pleuronectids without pigment bands by

- Pigment pattern
  - —Urostyle unpigmented
  - —No slash-like pigment along hypaxial myomeres
  - —Finfold pigment mainly restricted to anal finfold
- Size at transformation ~10 mm SL

[a] Pertseva-Ostroumova 1961

Ref: Ahlstrom et al. 1984a.




Figures A–C, F, Pertseva-Ostroumova 1961 (B–C, reversed); D–E, NWAFC originals (B. Vinter).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 37-38-39 |
| | Precaudal: 12-13-13 |
| | Caudal: 24-25-26 |
| **Branchiostegal rays** | 7-X-8 |
| **Caudal fin** | Total rays=19 |
| **Pelvic fin** | Thoracic |
| | R: 6-6-6 |
| **Dorsal fin** | R: 65-72-78 |
| **Pectoral fin** | R: 9-11-12 |
| **Anal fin** | R: 46-50-56 |
| **Gill rakers** | U: 3-X-4 L: 8-X-11 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to SE Alaska, 55-59°N |
| **Ecology** | Epi- and mesobenthal, 0-350 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Mar-Aug (California)[a] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.20-1.56 mm |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous |
| **Envelope** | Sculptured with polygonal pattern |
| **Hatch size** | 3.9 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

- Egg diameter (1.20-1.56 mm)
- Polygonal sculpturing on envelope surface

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | 6.2-8.5 mm NL |
| **Length at transformation** | 8.2->11.4 mm SL |
| **Sequence of fin development** | Caudal slightly before dorsal and anal, pelvics, pectorals |

**Pigment**

- Preflexion larvae: Opposing pigment clusters on dorsal and ventral finfolds, increasing with development
- Small melanophores covering all but posterior 1/4 of body

**Diagnostic characters** (see Table 3)

Distinguished from other pleuronectids without pigment bands by

- Heavy pigment pattern

Distinguished from *P. decurrens* by

- Pigment pattern: *P. coenosus* has less finfold pigment than *P. decurrens*
- Precaudal vertebrae 12-13, whereas *P. decurrens* usually has 14-15
- Lack of pterotic spines

Note: Preflexion larvae occasionally have more snout and lower jaw pigment than shown on figure.

[a] Budd 1940

Ref: Ahlstrom et al. 1984a, Sumida et al. 1979.

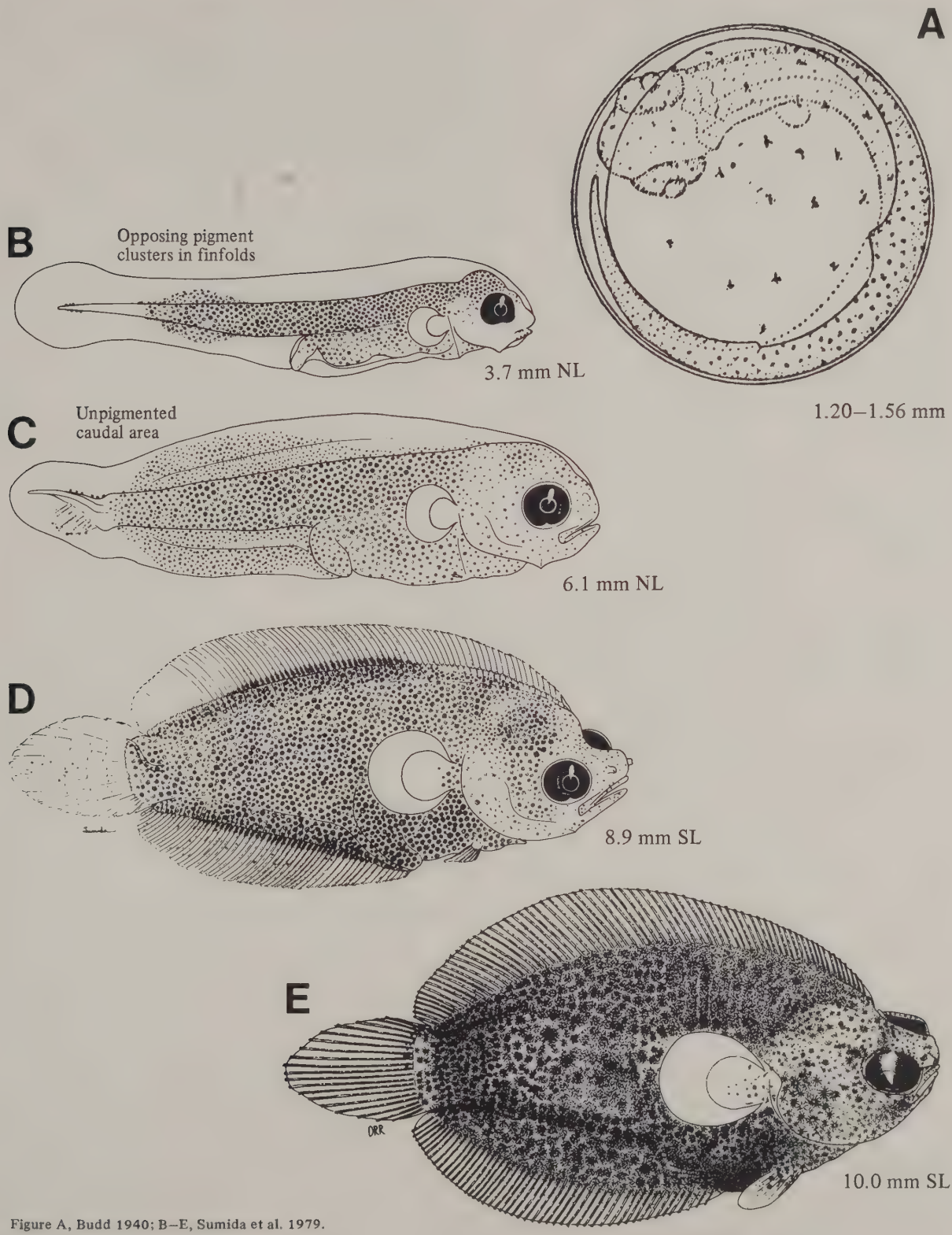



Figure A, Budd 1940; B–E, Sumida et al. 1979.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 38-39-41 |
| | Precaudal: 13-14-15 |
| | Caudal: 24-25-26 |
| **Branchiostegal rays** | 7-X-8 |
| **Caudal fin** | 2, 7+7, 2 |
| | Total rays=19[a] |
| **Pelvic fin** | Thoracic |
| | R: 4-6-7 |
| **Dorsal fin** | R: 67-75-81 |
| **Pectoral fin** | R: 9-12-14 |
| **Anal fin** | R: 45-50-55 |
| **Gill rakers** | U: 3-X-4 L: 6-X-9 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Bering Sea, 54-66°N |
| **Ecology** | Epi-, meso-, and bathybenthal, 8-532 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 1.84-2.08 mm |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous |
| **Envelope** | Sculptured with polygonal pattern |
| **Hatch size** | 4.9-5.5 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

- Egg diameter (1.84-2.08 mm)
- Polygonal sculpturing on envelope surface

### LARVAE

| | |
|---|---|
| **Preanal length** | ~50% SL |
| **Length at flexion** | 7.8-11.0 mm NL |
| **Length at transformation** | 10.5->21.0 mm SL[b] |
| **Sequence of fin development** | Caudal slightly before dorsal and anal, pelvics, pectorals |

**Pigment**

- Nearly entire body and finfolds pigmented except posteriorly in preflexion larvae; banding pattern develops in postflexion larvae

**Diagnostic characters** (see Table 3)

Distinguished from other pleuronectids without pigment bands by

- Heavy pigment pattern
- Pterotic spines

Distinguished from *P. coenosus* by

- See *P. coenosus* (p. 616)
- In addition to having pterotic spines, more pigment, and more precaudal myomeres, *P. decurrens* is larger at various stages of development (see figures).

[a] 12 branched rays.
[b] Eye migration by 10 mm SL, but not complete in some until >21 mm SL.

Ref: Ahlstrom et al. 1984a, Sumida et al. 1979.

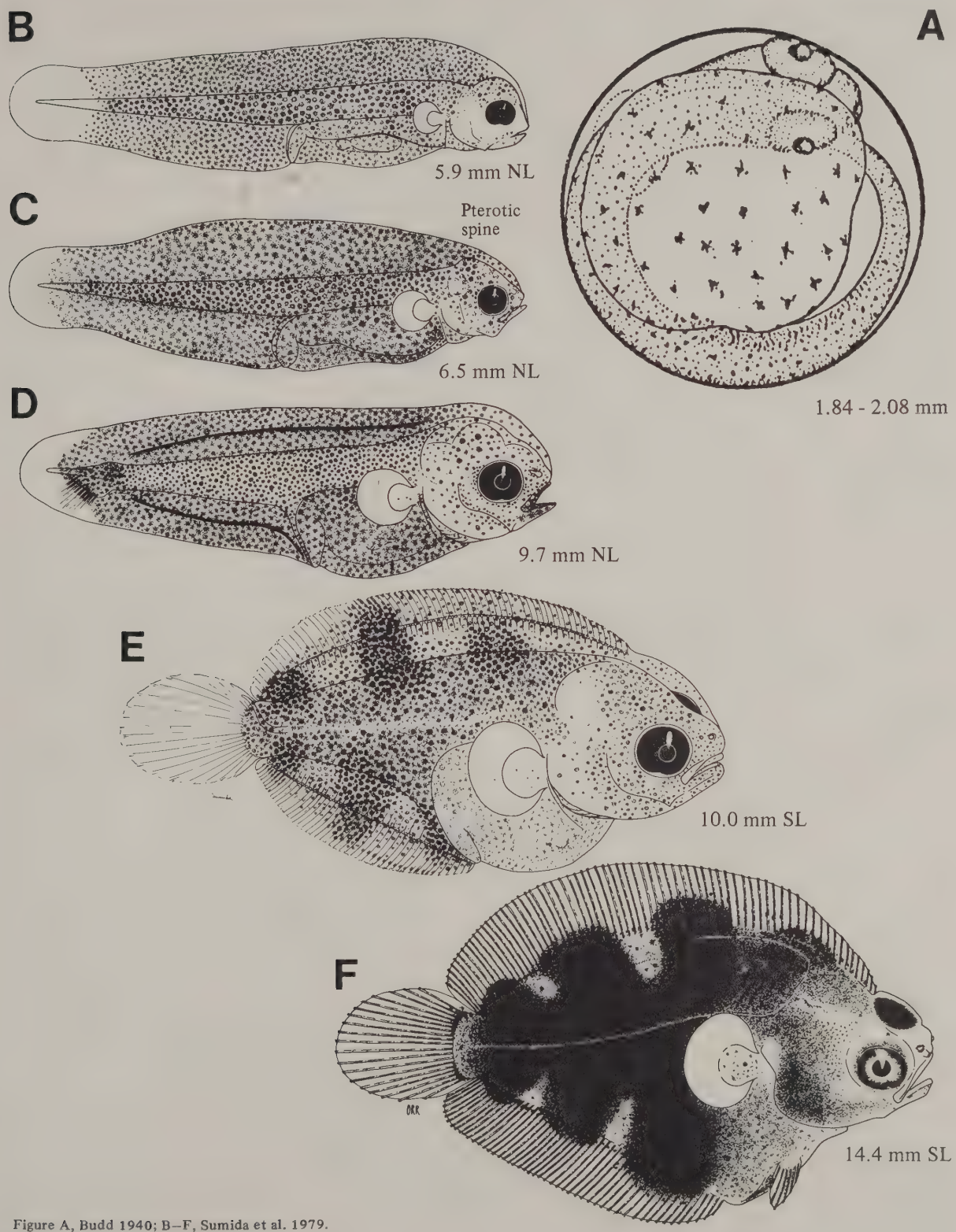



Figure A, Budd 1940; B–F, Sumida et al. 1979.

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 38-39-41 |
| | Precaudal: 11-11-12 |
| | Caudal: 28-28-30 |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | 2, 7+7, 2 |
| | Total rays=18[a] |
| **Pelvic fin** | Thoracic |
| | R: 6-6-6 |
| **Dorsal fin** | R: 73-85-88 |
| **Pectoral fin** | R: 10-X-12 |
| **Anal fin** | R: 53-58-62 |
| **Gill rakers** | U: 5-X-7 L: 14-X-18 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | S. California, 32-34°N, to Bering Sea, 54-66°N |
| **Ecology** | Epi- and mesobenthal, 1-325 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Jan-Mar (Puget Sound);[b] July (British Columbia)[c] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | 2-3 yr (females)[d] |
| | 2 yr (males)[e] |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 0.83-1.04 mm |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | Clear |
| **Envelope** | |
| **Hatch size** | <3 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

- Yolksac: May appear as early as late middle stage

**Diagnostic characters**

See *Isopsetta isolepis* (p. 594); usually pigment on yolksac and in later stages on finfold

### LARVAE (see discussion, p. 599)

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | ~8-10 mm SL |
| **Length at transformation** | >22.6 mm SL |
| **Sequence of fin development** | Caudal, dorsal and anal, pelvics, pectorals |
| **Pigment** | |

- Postanal body
  - —3-4 large spots along ventral midline
  - —Three spots along dorsal midline; the first spot more anteriorly placed than the first ventral spot
- Prominent pigment along edges of dorsal and ventral finfolds
- Mouth, isthmus
- Gut pigmented along ventral midline and posterior edge

**Diagnostic characters**

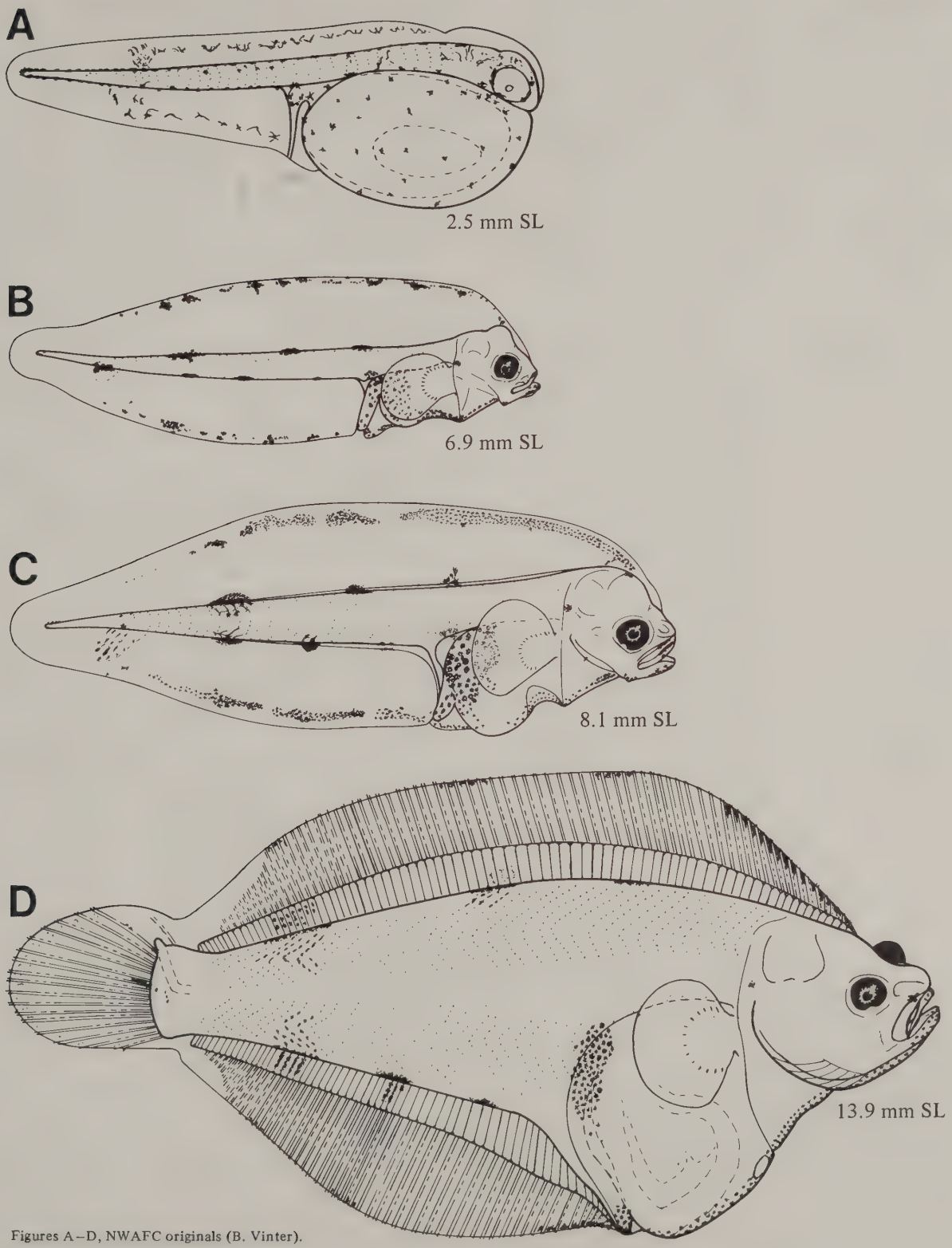
See *Lepidopsetta bilineata* (p. 596) and *Lepidopsetta* 2 (p. 599)

Distinguished from other pleuronectids with pigment bands by

- Distinctive pigment along edges of dorsal and ventral finfolds and dorsal and ventral body midlines

[a] 12 branched rays.
[b] English 1961
[c] Manzer 1947
[d] Smith 1936

Ref: Ahlstrom et al. 1984a.




Figures A–D, NWAFC originals (B. Vinter).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 61-63-64 |
| | Precaudal: 17-18-19 |
| | Caudal: 43-45-46 |
| **Branchiostegal rays** | 7-7-7 |
| **Caudal fin** | |
| **Pelvic fin** | Thoracic |
| | R: 5-6-7 |
| **Dorsal fin** | R: 83-97-105 |
| **Pectoral fin** | R: 11-14-15 |
| **Anal fin** | R: 63-72-79 |
| **Gill rakers** | U: 3-X-6 L: 11-X-16 |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Chukchi Sea, north of 66°N |
| **Ecology** | Epi-, meso-, and bathybenthal, 14-2000 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Fall[a] |
| | Area: Continental slope (>100 m)[a] |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: 15,000-215,000 (Atlantic)/ $F=0.000063\times L^{4.66}$, L=FL cm[a] |
| **Age at first maturity** | 13 (females, Okhotsk Sea)[a] |
| **Longevity** | >23 yr[a] |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 4.0-4.5 mm |
| **No. of oil globules** | None |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous |
| **Envelope** | Smooth, transparent |
| **Hatch size** | 10-16 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

### LARVAE

| | |
|---|---|
| **Preanal length** | <50% SL |
| **Length at flexion** | 25-27 mm SL |
| **Length at transformation** | 45-65 mm SL |
| **Sequence of fin development** | Caudal, dorsal and anal, pelvics, pectorals |

**Pigment**

- Ventrally and posterolaterally on gut
- Light ventrolateral pigment along body from above gut, some dorsal, along peduncle; also in finfold above and below tail (∼posterior 1/3)
- Increase in pigmentation in postflexion specimens

**Diagnostic characters**

- Newly hatched larvae large and unpigmented (except for eye)

Distinguished from other pleuronectids with >60 myomeres by

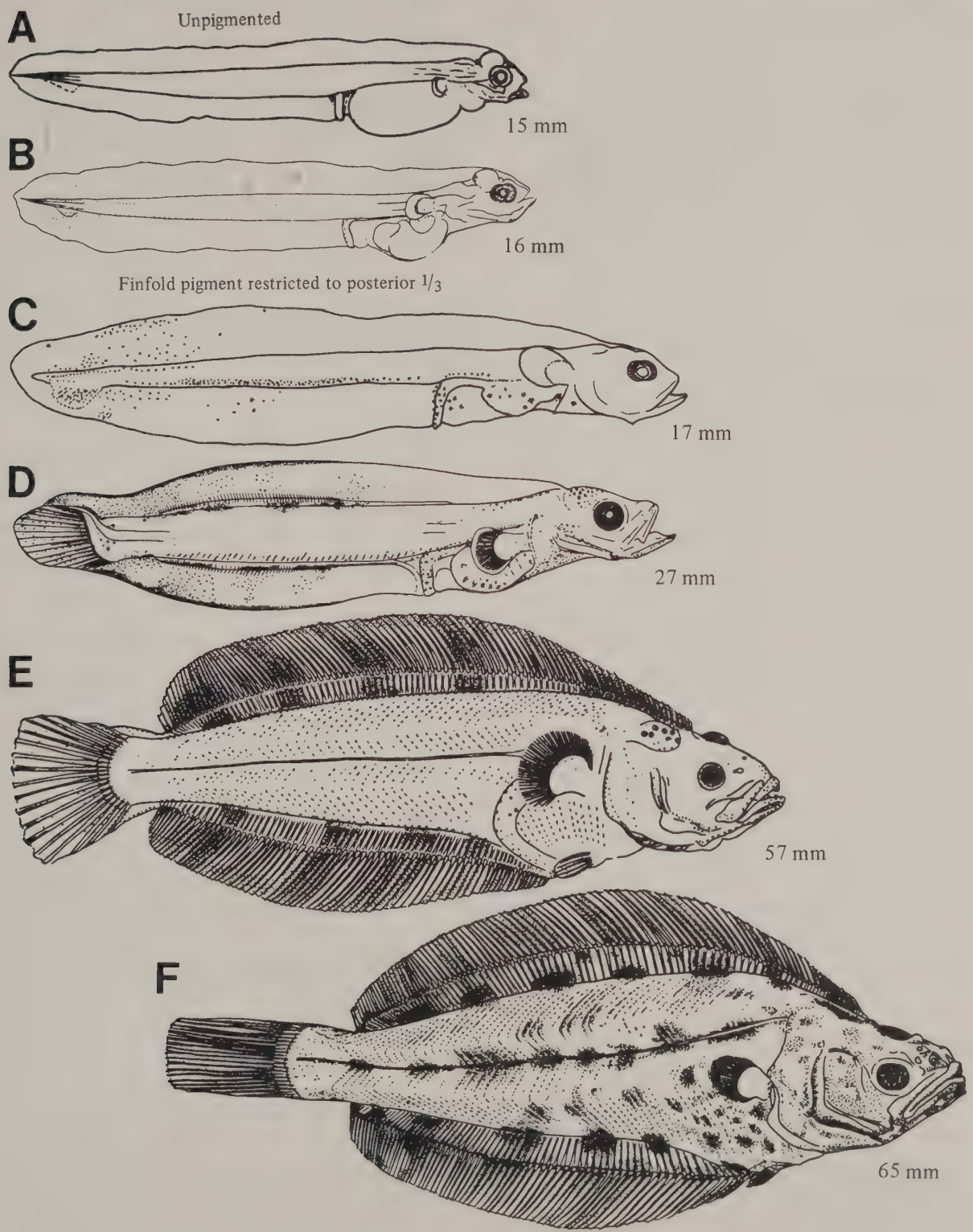
- No band pattern and overall lightly pigmented
  - —*Glyptocephalus zachirus* (p. 586): Four postanal bands with more lateral intensity
  - —*Embassichthys bathybius* (p. 580): Three postanal bands

Distinguished from *Hippoglossus stenolepis* (p. 592) (both have large unpigmented yolksac larvae) by

- Depth of collection (>200 m)
- High myomere count (61-64)
- Hatch size (10-16 mm SL)

[a] Dunn and Sample 1976

Ref: Ahlstrom et al. 1984a, Jensen 1935.




Figures A–F, Jensen 1935 (A–D, reversed; specimens collected from West Greenland waters).

## MERISTICS

| | |
|---|---|
| **Vertebrae** | Total: 50-51-52<br>Precaudal: 9-9-9<br>Caudal: 41-X-43 |
| **Branchiostegal rays** | 6-6-6 |
| **Caudal fin** | Total rays = 12[a] |
| **Pelvic fin** | Thoracic; 4 rays on eyed side, absent on blind side |
| **Dorsal fin** | R: 95-X-106 |
| **Pectoral fin** | Present during larval period but lacking in juvenile and adult stages |
| **Anal fin** | R: 77-X-90 |
| **Gill rakers** | U: X-X-X L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to Oregon, 42-46°N |
| **Ecology** | Nearshore shelf demersal, 1-201 m |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: June-Sept[b]<br>Area:<br>Mode:<br>Migration: |
| **Fecundity** | Range/function: |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | 0.71-0.78 mm |
| **No. of oil globules** | Multiple, 10-23 |
| **Oil globule diameter** | |
| **Yolk** | Homogeneous |
| **Envelope** | Smooth, colored |
| **Hatch size** | 1.9 mm SL |
| **Incubation time/temp.** | |
| **Pigment** | |

**Diagnostic characters**

- Multiple oil globules

### LARVAE

| | |
|---|---|
| **Preanal length** | 50% NL decreasing with development to 28% SL |
| **Length at flexion** | 9.4-10.8 mm SL |
| **Length at transformation** | 19.0-24.2 mm SL |
| **Sequence of fin development** | Anterior dorsal; caudal, dorsal, and anal; pelvics[c] (pectorals disappear at metamorphosis) |

**Pigment**

- Small melanophores along dorsal midline, larger along ventral midline
- Single band posteriad on tail
- Large blotches at finfold margin, with development restricted to along the distal edges
- Head, gut, and swimbladder

**Diagnostic characters**

- Morphology: Large head and tapering body
- Gut mass trails posteriad
- Five exserted dorsal fin rays develop by 6.0 mm SL but they are no longer than other fin rays (in other species of *Symphurus*, elongate anterior dorsal fin rays persist)
- Pelvic fin on blind side begins disappearing at 18.0-22.0 mm SL[c]

[a] All rays on hypurals, all unbranched.
[b] Fitch and Lavenberg 1975
[c] E.H. Ahlstrom notes

Ref: Ahlstrom et al. 1984a.

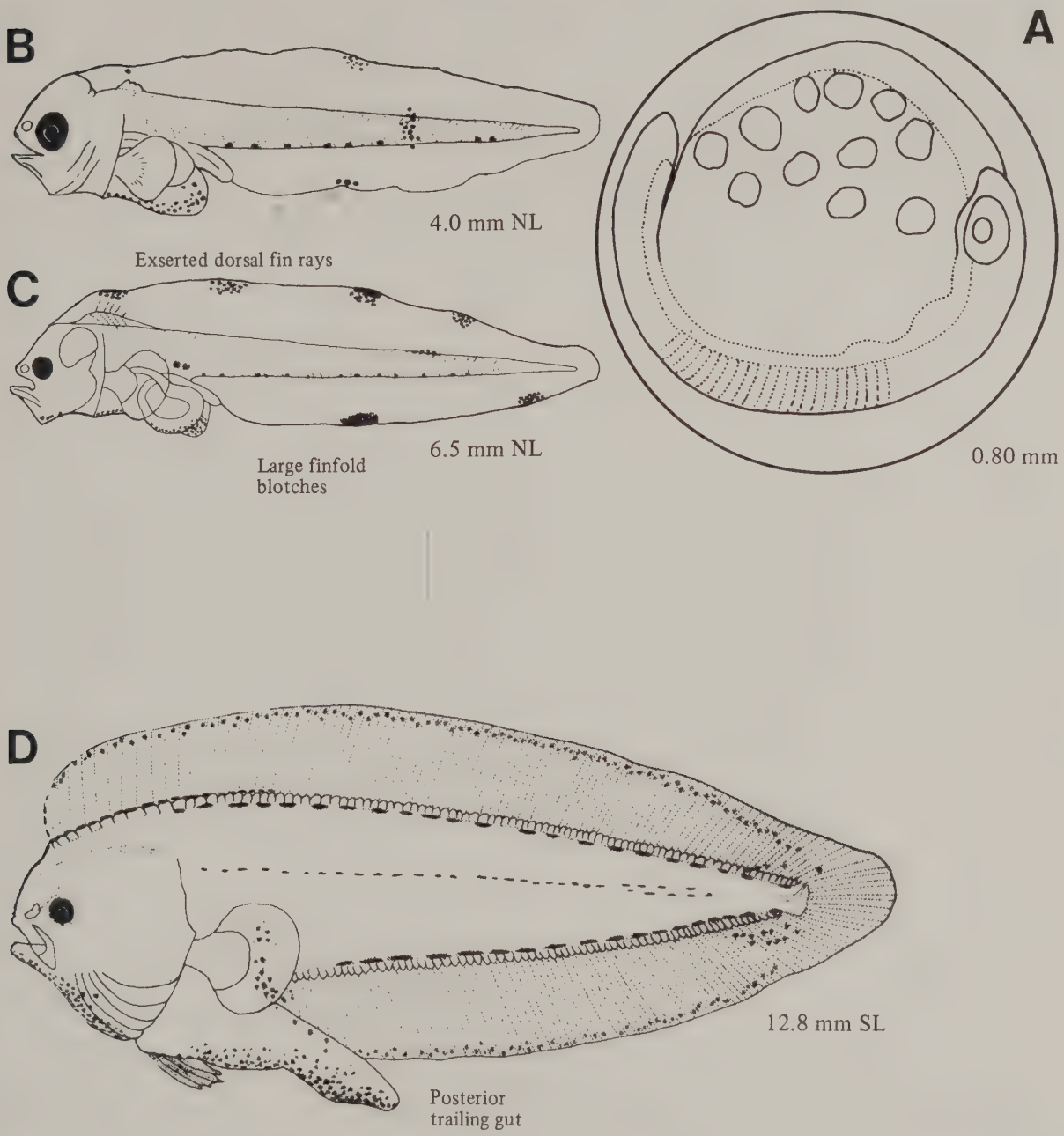
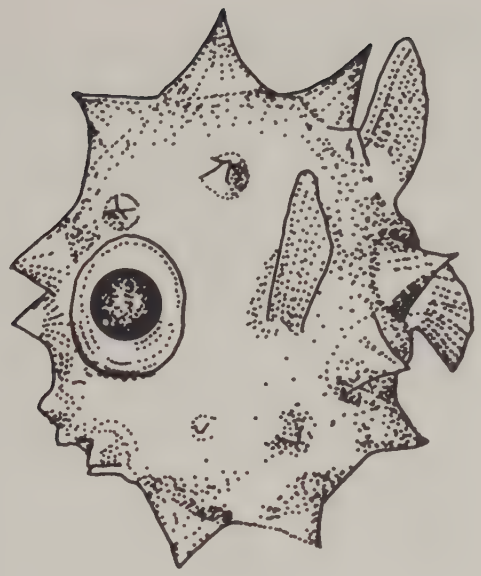



Figure A, Matarese and Sandknop 1984; B–D, Ahlstrom et al. 1984a.



## Tetraodontiformes

Although most fishes of the Tetraodontiformes are tropical and associated with the bottom, some are found in temperate zones and remain pelagic throughout their lifespans. The general body shape is rounded or boxlike and the body may be encased in a bony carapace or covered with sharp spines. Many species are able to inflate themselves with water or air. Eight families, 92 genera, and 329 species make up the order (J. Nelson 1984). Only one family, Molidae, is found in the Northeast Pacific. The most unusual of the tetraodontiforms, molids have no caudal fin and propel themselves with large dorsal and anal fins. Eggs are pelagic, 1.42-1.80 mm in diameter, and have multiple oil globules (Leis 1984). Larvae hatch with a functioning jaw, pigmented eyes, and a dermal sac enclosing the head and trunk. With development, body spines form and the tail atrophies. Molids may have a long prejuvenile stage marked by retention of spines and a shape unlike that of adults (Leis 1984).

Family in study area: **Molidae**

## MERISTICS

| | | |
|---|---|---|
| **Vertebrae** | Total: 17-X-18 | |
| | Precaudal: 8-X-9 | |
| | Caudal: 8-9-9 | |
| **Branchiostegal rays** | 6-6-6 | |
| **Caudal fin** | Absent | |
| **Pelvic fin** | Absent | |
| **Dorsal fin** | R: 15-X-18 | |
| **Pectoral fin** | R: 11-X-13 | |
| **Anal fin** | R: 14-X-18 | |
| **Gill rakers** | U: X-X-X | L: X-X-X |

## LIFE HISTORY

| | |
|---|---|
| **Range** | South of southern California to SE Alaska, 55-59°N |
| **Ecology** | Epipelagic |
| **ELH pattern** | Oviparous, pelagic eggs, pelagic larvae |
| **Spawning** | Season: Spring-summer[a] |
| | Area: |
| | Mode: |
| | Migration: |
| **Fecundity** | Range/function: 300 million[b] |
| **Age at first maturity** | |
| **Longevity** | |

## EARLY LIFE HISTORY DESCRIPTION

### EGGS

| | |
|---|---|
| **Diameter** | |
| **No. of oil globules** | |
| **Oil globule diameter** | |
| **Yolk** | |
| **Envelope** | |
| **Hatch size** | <1.84 mm TL |
| **Incubation time/temp.** | Other members of family hatch in 7-8 days |
| **Pigment** | |

**Diagnostic characters** - Family

- Pelagic, large (1.4-1.8 mm), and have multiple oil globules

### Larvae

| | |
|---|---|
| **Preanal length** | <50% SL increasing with development to >50% SL |
| **Length at flexion** | Does not occur |
| **Length at transformation** | Long ontogenetic stage between larvae and juveniles |
| **Sequence of fin development** | Pectorals and caudal, dorsal and anal |

**Pigment** - Family

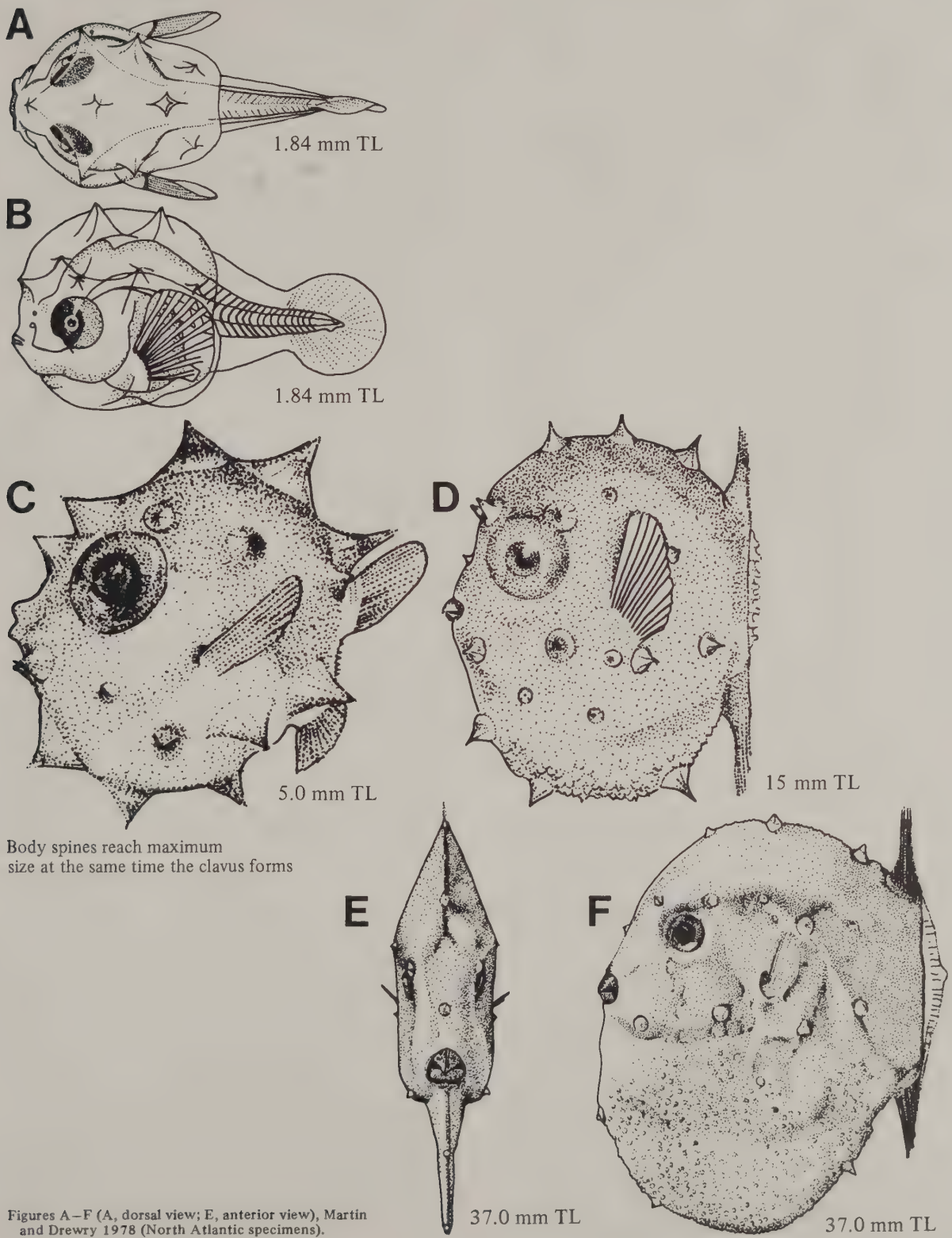
- Usually heavily pigmented over gut and dorsal surfaces

**Diagnostic characters**

- Morphology: Wide, deep body
- Body spines with a ventral keel (form soon after hatching)
- Tail in young is normal but soon atrophies and a true caudal never forms; notochord flexion does not take place, so the clavus (gradual thickening near the distal end) is not homologous with the caudal fin[c]

[a] Martin and Drewry 1978
[b] Hart 1973
[c] Leis 1984

Ref: Leis 1984.




Body spines reach maximum size at the same time the clavus forms

Figures A–F (A, dorsal view; E, anterior view), Martin and Drewry 1978 (North Atlantic specimens).

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